

# The Blast Furnace *and* Steel Plant

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# The Blast Furnace *and* Steel Plant

Vol. XIII

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No. 10

## Silence as a Weapon

THAT portion of our Eastern States which has always considered itself dependent upon anthracite coal has been in the grip of a miners' strike since September first. ¶ Such a cutting off of this normal fuel supply has hitherto been looked upon as a calamity, and as such has always filled the daily news. Apparently those directly active have received much pleasure and profit from the agitation of their customers as they scrambled for a vanishing supply at rapidly mounting prices.

Procedure is different in 1925.

No one seems to know that the anthracite "vacation" is on. The papers barely mention the fact, and although about a month has elapsed since mining operations ceased, no one is giving the matter a moment's worry.

Many factors present new faces upon a problem which heretofore seemed to have but one. There are now a variety of fuels which offer all the advantages of anthracite and none of the disadvantages. The East has awakened to this and users are rapidly making the change-over.

But of all the factors, silence is most effective. A public which refuses to talk about a problem has forgotten that a problem exists, and when that time arrives, as it seems to have in this instance, there is little left to do but go back to the mines and work.



# Inspecting and Testing Automobile Axles

The Tremendous Demands of Axle Service Require That Every Possible Test Be Used That Will Help Make the Finished Product One of Absolute Dependability

By R. L. ROLF\*

SINCE the time of Captain Cugnot of 1769-70 with his three-wheeled artillery carriage, the development of the motor car has made rapid strides. Slowly at first as may be seen by the advancement from Cugnot's artillery carriage to Richard Trevithick's steam road carriage in 1802, thence to Gurney's steam coaches in the early twenties of the nineteenth century which was later followed by the magnificent record of Walter Hancock, who built nine steam road carriages of which six were placed in actual service between the years 1828 to 1839. In 1829 Jame's coach made its first appearance and is the first to be on re-

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ord of having a mechanical device for allowing differential action on the rear wheels.

Step by step the automotive industry paved its way until in the early part of the twentieth century it made progress in leaps and bounds, and only a tedious search of the patent records will give a vague history of the automobile and tell the story of the life of some inventors who spent their energies in perfecting coiled spring and clock work motors, carriages provided with masts and sails, steam propelled vehicles, vehicles driven by compressed air, etc., up to the present time of the gasoline motor.

Through these dark ages, keeping pace with the progress and development of the motor car, in fact a

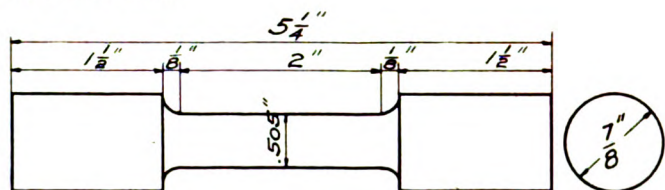


FIG. 1

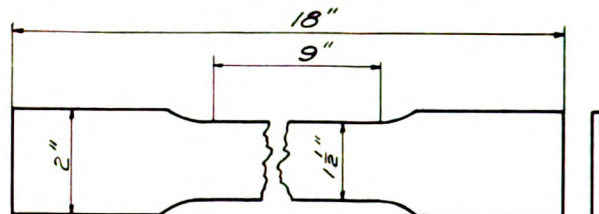


FIG. 2

FIGS. 1 and 2. — Standard test bars machined from specimens and used to determine ultimate strength, yield point, elongation and reduction of areas.

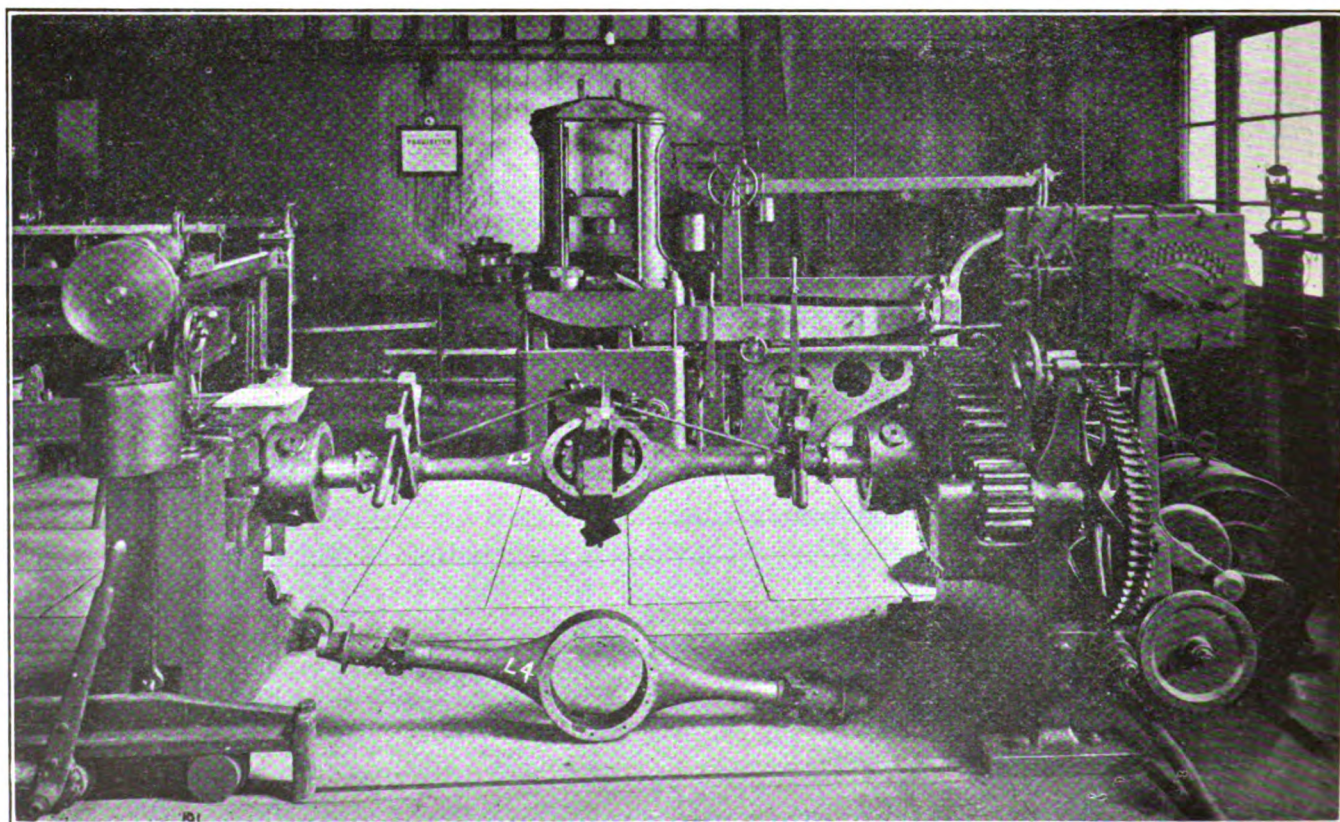


FIG. 3 — Testing a rear axle housing in torsion.



little ahead of it, was the automobile axle, and it had to, for what progress could the motor car make, if the axle one of the most important parts of a motor driven vehicle lagged behind. It is up to this component to carry the entire weight of the car and its load, besides transmitting the motor's power to the driving wheels. It must support the brakes which stop the car and divide the motor's power between the

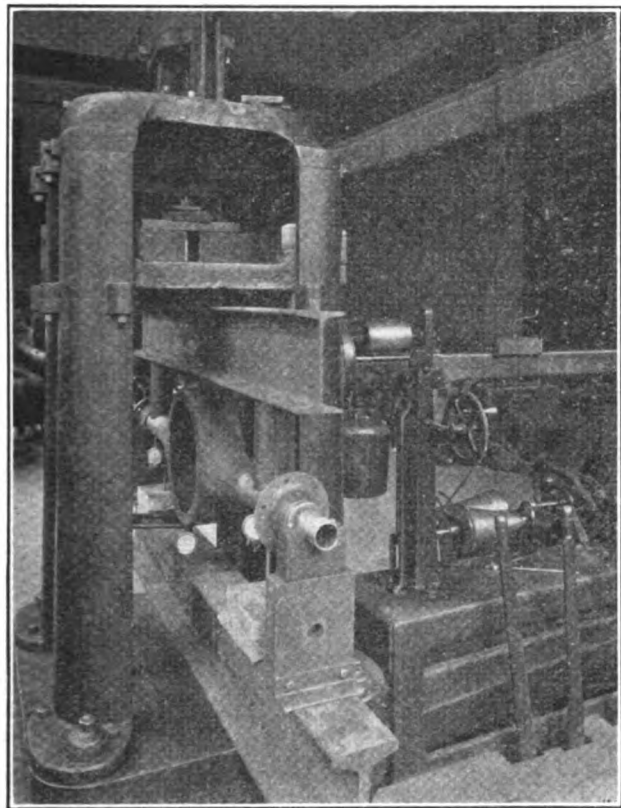


FIG. 4. — Cross bending test on rear axle housing

two rear wheels so that one may revolve more rapidly than the other when rounding a corner, it must hold the rear wheels in line against shocks caused by dropping into chuck holes, skidding and striking curbs, and it must at all times permit the driver to steer unerringly.

To meet these tremendous demands of axle service a careful study of a multiplicity of analysis, heat treatments and tests are required so that each axle part has that material which will allow it to function the best.

Axles are designed to meet the every-day requirements with a large margin of safety, and the materials which enter into their fabrication are so selected and treated that should they be submitted to undue stress the axle will stand up under the last ounce of pressure and severe shock, and then bend but not break.

In the axle industry as well as others, testing is carried out on a commercial scale to insure that the proper material is provided and that the material has been properly handled in its process of manufacture.

To those who have had experience in the testing and selecting of axle steels nothing need be said, but those who have not had experience, an outline of the test and inspection methods that are used in order to secure the best results, may be useful.

### Chemical Test.

The first step in the inspection and testing begins with the material from which the parts are to be fabricated and starts with the proper segregation of the material when it is received at the plant.

Billets and bar stock are usually shipped from the mill in separate heats and the heat numbers are either stamped or painted on the ends of the bars. When this material is received it is stored so as to keep each heat separate and is so marked or painted as to keep the identification known at all times.

Forgings, if purchased from an outside source are a little more difficult to handle, as they are usually shipped in quantities varying from ten or a dozen pieces to carload lots. And again each shipment may consist of forgings, which have been forged from one or more heats of steel. Care is therefore exercised in the checking of each reasonable size shipment of parts and also as to the proper tagging and storage of these shipments so that they may be identified at any future date.

On selecting the specimens for test, usually a percentage of the shipment is selected at random and

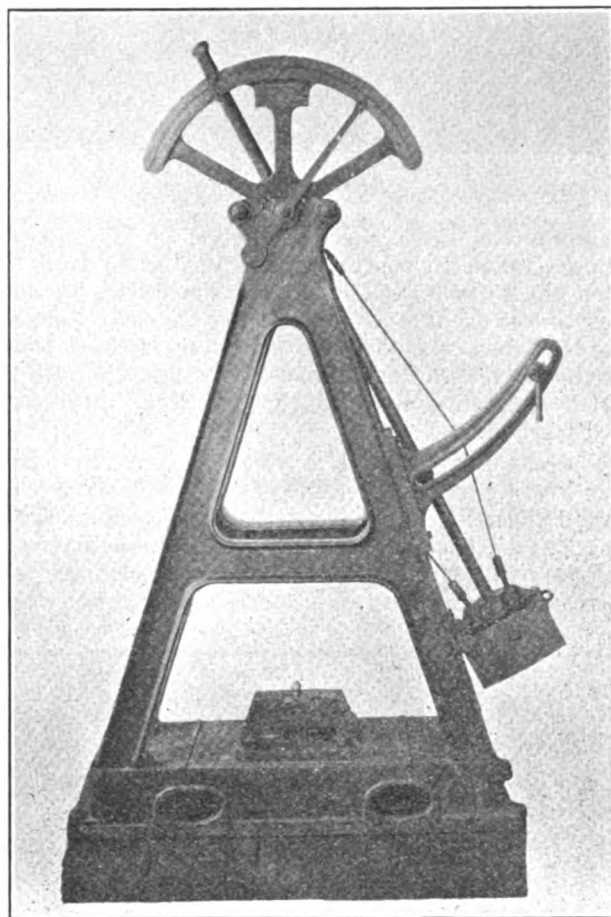


FIG. 5. — Impact test on steering balls.

turned over to the chemical laboratory for sampling and analysis.

The samples consist of drillings or chips made by some machine tool without the application of water, oil or any other lubricant and must be free from any foreign substance such as dirt, scale, grease, etc. Whenever it is found practicable the samples are taken midway between the outside and center by drilling parallel to the axis. Where this method is found to





FIG. 6. — Brinell test for hardness.

be impracticable the piece is drilled on its side and drillings taken to represent the portion midway between the outside and center of the part. In some cases this procedure would destroy a costly part and wherever this occasions the sampling is done to approach this method as closely as possible and still not destroy the component. Surface drillings in all cases are discarded.

The chemical analysis is one of great importance when testing steel for axle parts, for it is by this method that the material can be placed in its proper category; as it is the chemical composition that regulates the heat treatment and partially determines what the resultant mechanical properties are to be.

This method of inspection is of unestimable value when testing for objectionable impurities, or whether the carbon content is too high or too low, whether the manganese content is outside of the specified range and whether or not a straight carbon steel had been substituted for an alloy, all of which should be determined before converting the material into the finished product.

The proportion of impurities permitted depends to a considerable degree upon the conditions to which the part or material is subjected, and not only is the quantity of importance, but likewise its distribution. This being especially true of the elements phosphorus and sulphur.



FIG. 7. — Shore test for hardness.

Sulphur prints made on material to show the distribution of this element, and specimens which have been etched with "Steads" reagent to show phosphorus banding have often proved invaluable.

#### Mechanical Tests.

Just as important as the chemical analysis is mechanical testing. Various parts have different func-

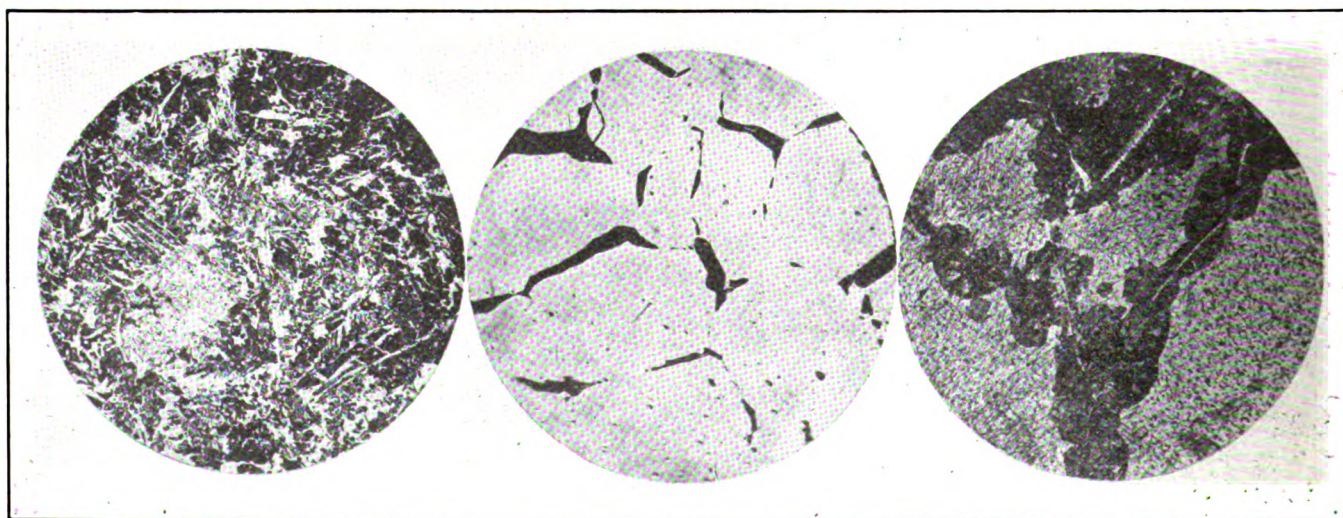


FIG. 8 (left) — Structure of a badly overheated forging (etched). FIG. 9 (center) — Same as Fig. 8, but unetched. FIG. 10 (right) — Forging of .35 carbon steel, showing large crystals caused by overheating.



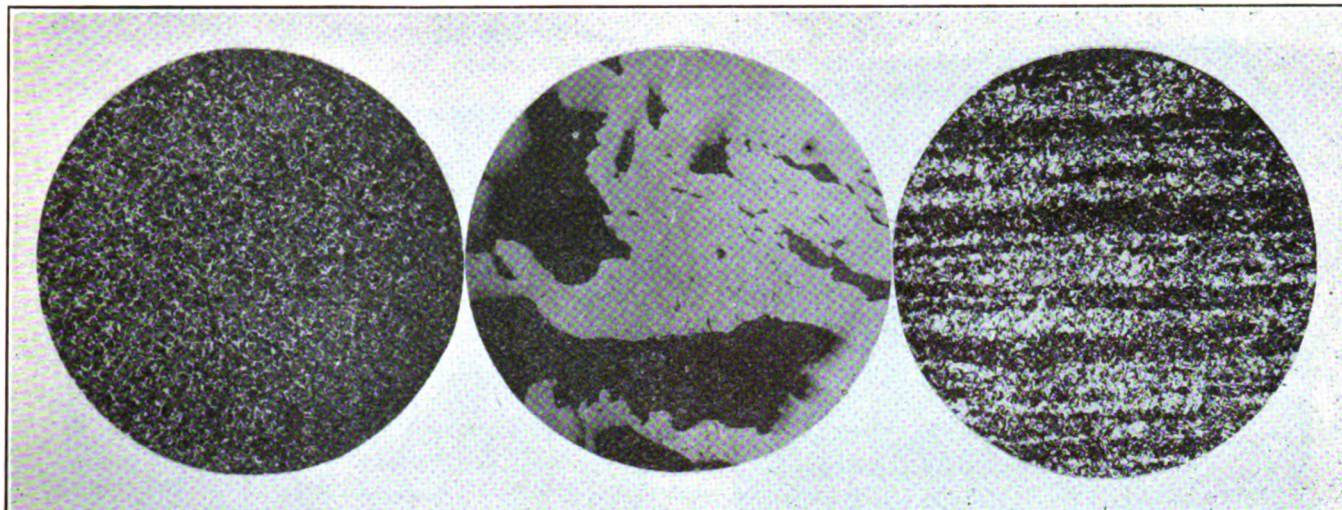


FIG. 11 (left) — Same steel as Fig. 10, showing how the grain has been refined by proper heat treatment. FIG. 12 (center) — Structure found in piped stock. FIG. 13 (right) — Ghost lines produced by mechanical working of segregated material.

tions to perform. The front axle I-beam must not only be capable of withstanding static and torsional resistance, but must withstand vibrations as well. Rear axles have to withstand the vibrations of the road, carry portion of the load and at the same time withstand the stresses caused by braking. The steering mechanism must be strong, tough and capable of resisting impact. The differential gears are subjected to wear and must be capable of withstanding this action, and so on, each component part may be affiliated with some specific duty it must successfully perform.

By correlating and adjusting steels of various analysis with different heat treatments various combinations of dynamic and static strength may be obtained. Certain types of steel are most favorable for static loads while others will show a marked affect upon the dynamic properties of the material. By combining a suitable steel with its proper treatment, a product most suitable for the purpose intended should result.

Once this standard is worked out, then it remains necessary to duplicate it with reasonable uniformity.

To reach this end there must be some practical guide that will permit the engineers to know with reasonable assurance that his results are being duplicated. Mechanical testing is one means by which these facts may be ascertained.

When making these tests the first consideration is that of the selection and preparation of the test specimen. The test may be conducted on the part itself, a representative test piece or upon an extension that may be forged or cast to the piece.

Where mechanical tests are conducted upon specimens taken from the part itself, then the piece chosen is taken from a section of the component that represents the mass of the whole part. When a prolongation is used for test purposes, it is given the same amount of work as the finished component, and where the finished part specifies heat treatment, then the prolongation is given the same treatment.

The most common method for determining static tests is the tension test. In these tests a standard bar similar to those illustrated in Figs. 1 and 2 are machined from the specimen, and gripped between the

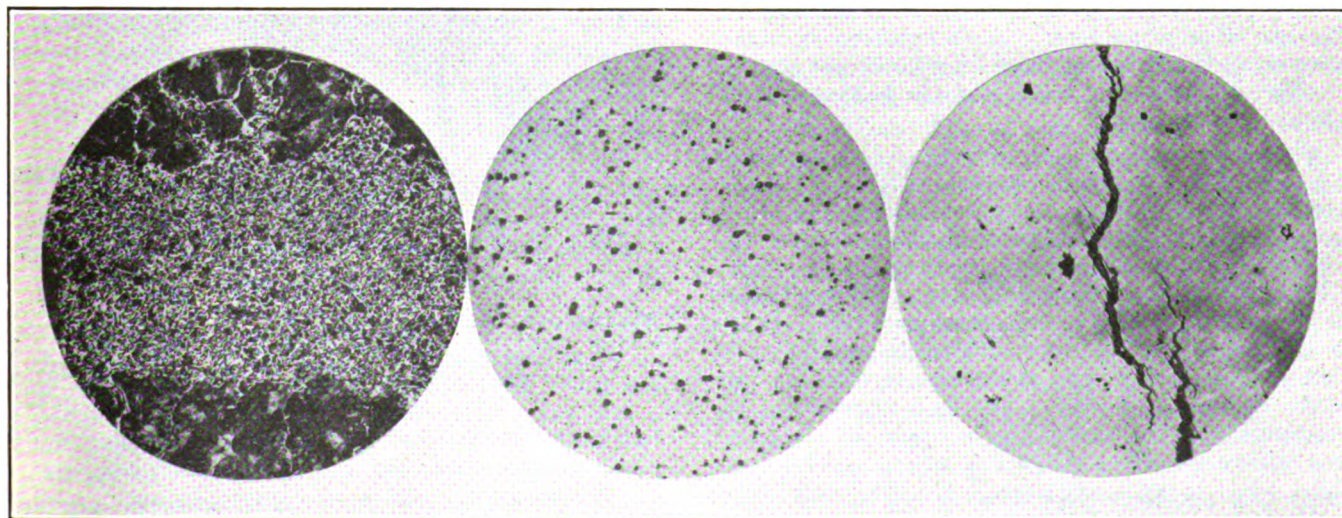


FIG. 14 (left) — Pronounced segregation of ferrite. FIG. 15 (center) — Section of an extremely dirty steel. FIG. 16 (right) — Showing how a crack will follow these inclusions, forming an easy path for rupture.



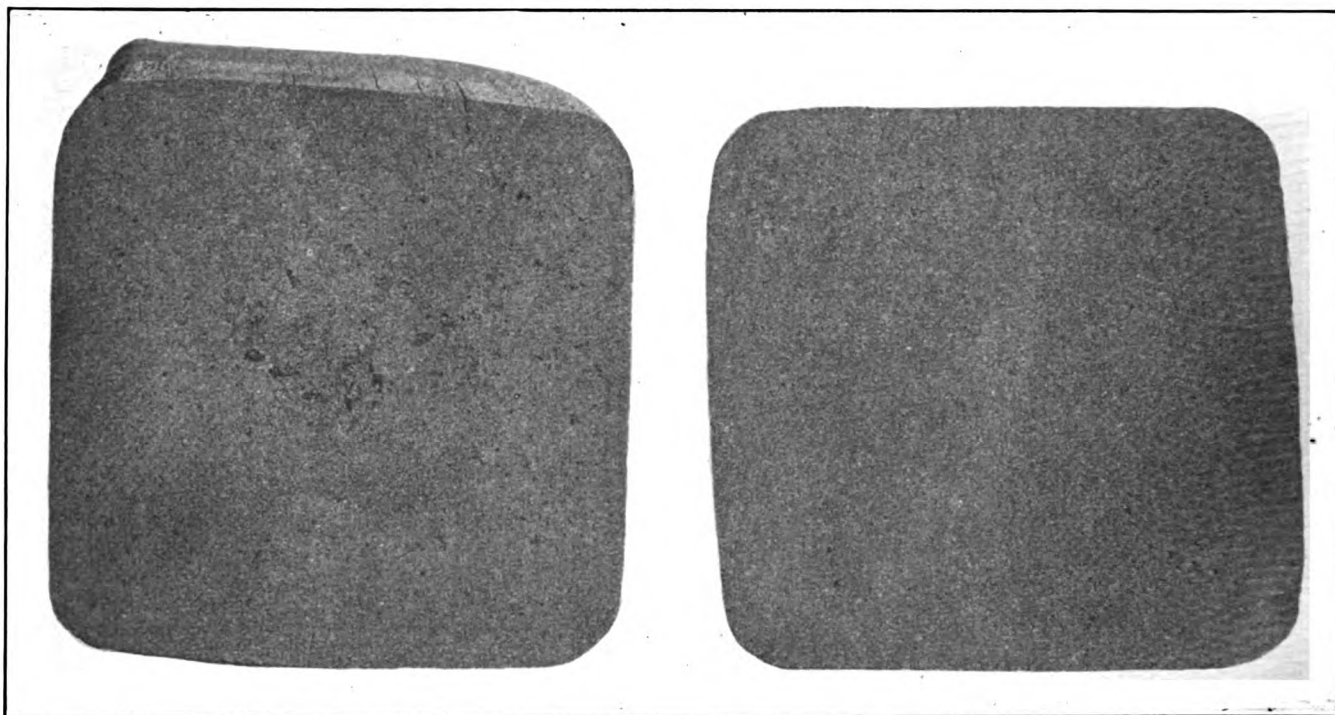


FIG. 17 — Etched cross section of defective billets.

jaws of a tension testing machine and pulled until it breaks. By this method of testing the ultimate strength, yield point, elongation and the reduction of area of the material is determined.

Front axle centers, steering arms, knuckles and rear axle drive shafts are all subjected to this type of test as one form of inspection. This method of inspection has its limits as it only indicates the manner in which the steel will act when subjected to a slow pulling load. In the actual service of an axle consideration has to be given to torque loads, impact and vibratory stress.

Drive shafts, front axle centers and rear axle housings, which have to withstand torque are subjected to torsion tests on their inspection, as well as tension. This test is used to determine the resistance of the part to twisting and is measured in inch pounds and the distortion in degrees. The elastic limit is obtained by the use of a tropometer. A comparison is made by computing the shearing stress in pounds per square inch. Fig. 3 shows the setup used in testing a rear axle housing in torsion.

Not only must the front axle center and rear axle housing resist torque loads, but they have to carry their respective share of the car's weight. To meet these requirements these parts are given an additional test known as the crossbending or transverse test. Fig. 4 illustrates the setup used while making these tests. The axle housing is supported on Vees at a distance equal to center to center of wheels and the load applied at both spring pads at a distance equal to the center to center of springs. The load is recorded in inch pounds and the deflection is noted by defectometers calibrated in 1/1000 part of an inch.

Impact is another stress that is not to be overlooked. Usually just the front axle I-beam and the steering ball are the only parts tested. When making this test on an I-beam, a notched test bar is machined

from the forging and tested. With the steering ball the complete component is tested. This means is used in determining the ability of the part to withstand a suddenly applied load or impact, thus determining the brittleness of the material. Steel that is inherently defective or made so by incorrect heat treatment can be readily noticed by this method of inspection. Likewise is this method valuable in correcting and establishing the proper heat treatment. Fig. 5 is a photograph of an Izod single impact testing machine with a steering ball in place ready for testing. The pointer and dial at the top of the machine indicates the number of foot pounds of energy which is absorbed in breaking the specimen.

All heat treated parts which enter into axle construction and that are not carbonized and hardened, are given a 100 per cent Brinell inspection. This is one method of checking the man at the furnace, as well as a partial assurance that no inferior material has through some way or other found its way into the finished product. Certain Brinell limits are established and every part has to meet these specifications before it can go into production.

Parts such as king pins, front axle bushings, gears, etc., which demand great hardness, are given both the scleroscope and the file test to check the hardness while in addition a percentage of every shipment is broken and the fracture examined.

#### Microscopic Study.

Metallography in its general sense is a study of the micro structure of metals; a science which up to a few years ago was practically unknown but which has advanced to that stage where it is now considered on a par with chemical and physical testing.

It is by this means that a check can be made upon the heat treatment of a part. It will show flaws and imperfections, and in many cases reveal the mechanical treatment to which the part has been subjected.



In testing axle parts, this mode of inspection is indispensable as it brings to light those defects which can ultimately ruin the product and which cannot be readily determined without the aid of a microscope.

An idea of just what story this method of inspection tells may be had by referring to micrographs 8 to 16.

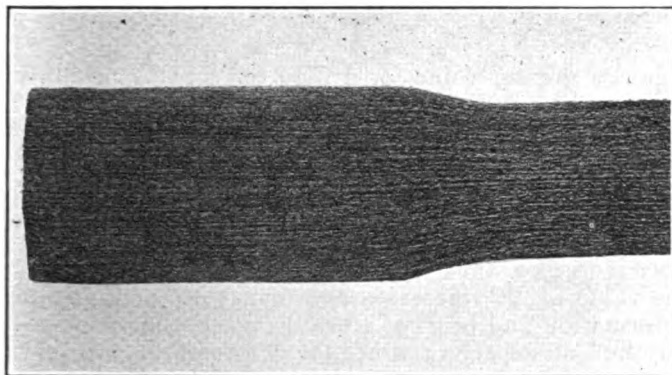


FIG. 18 — Grain flow in drive shaft.

Micrograph 8 illustrates the structure of a forging that had been very badly overheated.

Micrograph 9 is the same specimen as the previous micrograph, only in the polished state. This shows the gaps between the crystals, a condition that exists in badly overheated or burned material. Parts having structures as these have low fatigue resisting properties, and should not be used in the fabrication of axle parts.

Micrograph 10 shows the large crystals that exist in an overheated forging made from .35 carbon steel. Material showing this structure is likewise brittle and should not be used. This structure however can be restored by proper heat treatment.

Micrograph 11 is the same specimen as illustrated by micrograph 10, only it has been properly heat treat-

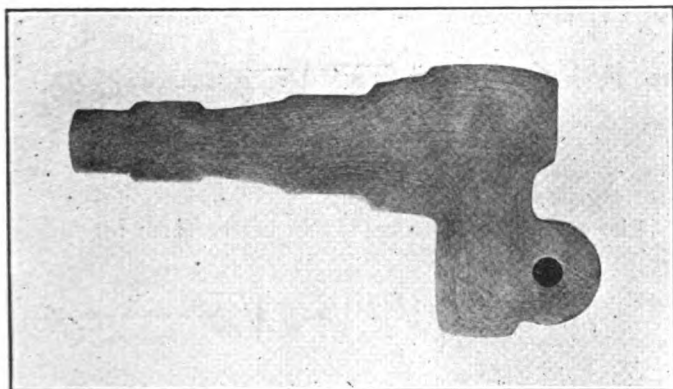


FIG. 19—Grain flow in steering knuckles.

ed. This shows a good commercial structure; it possesses strength and dynamic properties.

Micrograph 12 illustrates piped stock.

Micrograph 13 represents laminated material.

Micrograph 14 shows a large ferrite segregation.

Parts showing defects as illustrated by micrographs 12, 13 and 14 should never be used for axle parts unless these parts have very minor duties to perform.

Practically all commercial steels contain a certain amount of impurities and the amount that is permissible depends to a considerable degree upon their distribution and the function of the part. Good steel will have only a very small portion of impurities and these will be uniformly distributed throughout the metallic mass. When these impurities become numerous or tend to segregate then they become extremely dangerous and material showing these defects should not be used, as segregated material is usually weak and brittle as well as being hard on tools.

Micrograph 15 illustrates a section of a very dirty steel. Micrograph 16 illustrates how a crack will follow these inclusions forming an easy path for rupture.

Micrographs such as above illustrates only in a very small way the many of the daily uses of the microscope in solving metallurgical problems.

### Deep Etch Test.

Another form of inspection that is gaining favor in the inspection of axle steels is the deep etch test.

These tests are made by boiling a polished piece of the material for a certain length of time in a 50 per cent solution of hydrochloric acid. This method reveals any serious segregation or lack of homogeneity in the steel. It tells the crystalline condition of the bil-

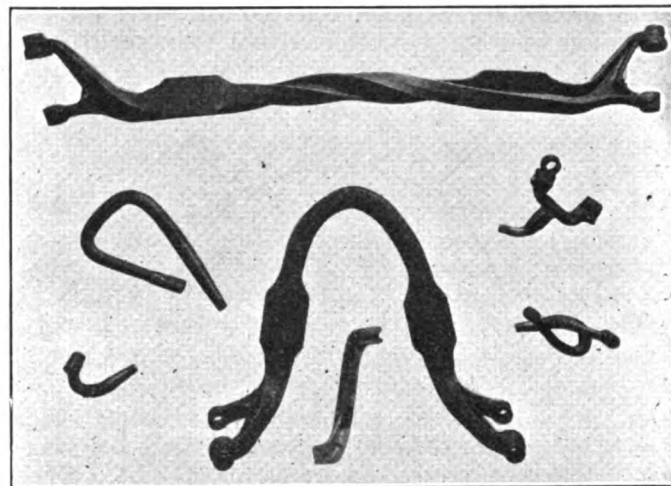


FIG. 20—Cold bend tests on heat treated parts.

lets, brings to light seams and cracks and also the degree to which the metal has been rendered fibrous.

Out of every heat of billets received a percentage is selected and subjected to this test, and only those heats which show sound steel are accepted and made into forgings. Photograph 17 shows two specimens of an alloy steel heat that had been etched to examine the internal structure. Attention is called to the shattered and porous condition of the cross section of these bars. Forgings made from material of this type would be very questionable.

Not only must a forging that enters an axle, be forged to a specified shape, but care has to be exercised to see that the grain flow in the finished forging is running in the proper direction to resist stresses. The flow of these fibers should be at right angles to the line of shear. Fig. 18 shows the grain flow in a section of a rear axle drive shaft made by the With-

(Continued on Page 418)



# The Design and Inspection of Gear Teeth For Wear

By P. M. GALLO\*

## PART II

IN order to apply this coefficient to gears it will be necessary to find the value of "q" in terms of "r" and R.

In Fig. 2 let A and B be a pinion and gear. Let ab and cd be the arcs respectively of their tooth faces.

First consider A and B of equal diameter as shown by full lines, then  $r = R$ , and the line of contact gh is straight as was shown by Fig. 1. The arcs ab and cd are shown completed by the dotted lines to show the deformation Delta 2 which corresponds to the roller deformation previously referred to. Consider gear B increased in diameter, consequently the tooth face radius will increase to R1 whose arc, ef, is shown by dot and dash lines. The line of contact gh is no longer straight but assumes the curved shape—ajh—as shown by the dot and dash lines. The deformation of this line to joint—j—denoted by Delta 1 in Fig. 2 corresponds to the deformation of the plate under the roller, as previously referred to. Since the deformations and areas considered are very small it is

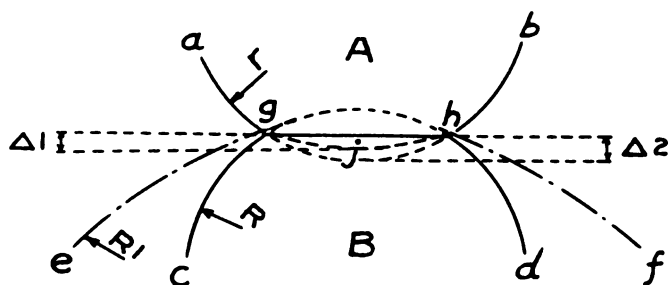


FIG. 2—Pinion and gear, with arcs of their tooth faces.

practically accurate to consider the deformation, Delta 1, to be proportional to R1, and the relative deformations must be expressed in terms of  $(r - R)$ . Since q has the limiting values of 0 and  $\frac{1}{2}$ , the expression containing  $(a - R)$  must have the same limits, which is fulfilled by

$$q = \frac{1}{2} \left( 1 - \frac{r}{R} \right) \text{-----} \text{Eq. (12)}$$

When  $R = r$ ,  $q = 0$ ; when  $R = 9r$ , which is the ratio for a gear of 360 teeth to a pinion of 10 teeth, then  $q = .45$ ; for a pinion or gear and rack, q is taken as  $\frac{1}{2}$ , disregarding face radius of rock.

Substituting this value of "q" in Eq. (11)

$$W = \sqrt{1 + 2 \left[ \frac{1}{2} \left( 1 - \frac{r}{R} \right) \right]} Z = \sqrt{2 - \frac{r}{R}} Z \text{-----} \text{Eq. (13)}$$

This equation is correct for any pair of gears, both being of the same material and  $e = E$ .

When the pinion and gear are made of the same material then the wear of the pinion teeth is  $(N \div n)$  times greater than that of the gear, consequently in practice the pinion is always made of a much harder and tougher material than the gear. This usually

means a greater value for e than for E; this means a smaller bearing area, hence a greater value for "K" thus increasing the wear on the gear, but decreasing same on the pinion. The friction is also reduced by the difference in the surface characteristics of the two materials. If the value of "E" decreases below that of "e" then the deformation, consequently the bearing area increases, thus increasing the load capacity. If the value of "E" increases above that of "e" then the deformation and bearing areas decrease, thus decreasing the load capacity. Since the deformations are very small, the radial deformation can be taken as inversely proportional to E without appreciable error. If both gears are of the same material, and the value of E be changed to e, then the deformation Delta in. at E will change to Delta in.  $(E \div e)$  for e. But if one gear retains its value of E, and the other gear is changed to the value e, the deformation will change to Delta in.  $([E + e] \div 2e)$ . If the value of E is used in Eq. (14) then the factor expression to be embodied in this equation to allow for the values of E and e in a pair of gears must be a decreasing one, thus

$$1 - \frac{E}{e} = \frac{e + E}{2e}$$

Since "a" and "W" vary as the square root of the deformation the final factor to be added to Eq. (14)

to make it universally applicable will be  $\sqrt{\frac{e + E}{2E}}$ , and Eq. (14) would become

$$W = \frac{4}{3} P F r S \sqrt{\frac{23}{E}} \sqrt{2 - \frac{r}{R}} \text{-----} \text{Eq. (14)}$$

This equation is general and can be applied to any pair of gears of any material, but correct for the involute gear teeth system only.

Placing this equation (15) in better form for quick solution,

$$W = \frac{4}{3} P F r S \sqrt{\frac{23}{E}} \sqrt{2 - \frac{r}{R}} \sqrt{\frac{E + E}{2E}} \text{-----} \text{Eq. (15)}$$

in this form it can be solved quickly by slide rule or logarithms.

Always use that value of "S" that corresponds to the lower value of "K" in a pair of gears. If both gears are of the same material there is only one value of "K" hence only one value of "S", but when of different materials there are two values of "K". Selecting the lower value of "K" find "S" from Eq. (5) and substitute in Eq. (16) or (15).

Formulas (15) and (16) are used for designing gears.

When a table of face and flank radii is not handy the following equations will give approximate values.



These values are very close but should be used for preliminary calculations only, using exact values for the final checking calculations.

$$W = \frac{4}{3} F p r \sqrt{2 - \frac{r}{R}} \sqrt{\frac{2S^3}{E}} \sqrt{\frac{E+E}{2E}} \text{-----} \text{Eq. 16}$$

Use up to 36 teeth inclusive, above 36 teeth the flank radius equals the face radius.

$$r = \left(\frac{n}{10} + 1\right) \cdot 22 \text{-----} \text{Eq. 17}$$

$$R = \left(\frac{N + \frac{40}{N}}{36}\right)^{\frac{2}{3}} 1.41 \text{-----} \text{Eq. 18}$$

Use up to 360 teeth inclusive.

Unless conditions determine otherwise the pinion is usually made as small as possible compatible with good practice. Rolling mill drive pinions should not have less than 20 teeth to give smooth action and long life. The value of "r" for 20 teeth is 0.60, therefore for preliminary calculations the following value for "R" can be used.

$$R = \left(\frac{20u + \frac{40}{20u}}{36}\right)^{\frac{2}{3}} 1.41 \text{-----} \text{Eq. 19}$$

If the value of E should be used in equation (14), then the factor expression to be added to make the equation applicable to a pair of gears of different materials must be an increasing one thus  $\sqrt{\frac{e+E}{2E}}$  and

and Eq. (14) would become

$$W = \frac{4}{3} F p r \sqrt{2 - \frac{r}{R}} \sqrt{\frac{2S^3}{E}} \sqrt{\frac{E+E}{2E}} \text{-----} \text{Eq. 20}$$

For a pair of gears whether Eq. (16) or Eq. (16a) is used, the result will be the same.

Application of formula (15) or (16) to gears of the cycloidal system.

To make this clear it will be necessary to refer to Fig. (1) again considering the roller "A" and plate "P" only, the plate deformation being equal to the roller deformation as per condition II, and letting  $D = 2r$ .

If the plate gradually curved convex to roller "A" the ratio of plate deformation to roller deformation for a given value of "S" has been shown to gradually decrease which is taken care of in Eq. (15) and (16) by the negative sign under the radical in the expression,  $r\sqrt{2 - (r \div R)}$ , the limiting value of the radius of curvature of the plate being "r" when this expression reduces to  $r\sqrt{2 - (r \div r)} = r$ . This applies to involute gears only for in these gears two convex arcs are tangent during the entire arc of action.

If the plate is curved concave to roller "A" the ratio of plate deformation to roller deformation will

increase, following the same law as for convex curves except that the sign under the radical of the expression  $r\sqrt{2 - (r \div R)}$  must be changed to plus to denote increased ratio of deformation, thus,

$r\sqrt{2 + (r \div R)}$ , again, the limiting radius of curvature of the plate will be r, and this expression reduces to  $r\sqrt{2 + (r \div r)} = r\sqrt{3}$ . This applies to cycloidal gears only for in these gears a convex curve is tangent to a concave curve during the entire arc of action. Therefore, for cycloidal gears the Eq. (16a) must be as follows:

$$W = \frac{4}{3} F p r \sqrt{2 + \frac{r}{R}} \sqrt{\frac{2S^3}{E}} \sqrt{\frac{E+E}{2E}} \text{-----} \text{Eq. 21}$$

This equation immediately shows one reason why cycloidal teeth wear better than involute teeth. For the same value of W, the contact area is greater, hence the value of K is less, and the smaller the value of "K" the longer the life of the gear.

For the purpose of investigating gears Eq. (16a) and (20) must be solved for "S", the resulting equations being as follows:

For involute gears, Eq. (16a) solved for "S":

$$S = \sqrt[3]{\frac{18}{32} \frac{CE}{E+E} \frac{W^2}{F^2 r^2 (2 - \frac{r}{R})^2}} = .8255 \sqrt[3]{\frac{CE}{E+E} \frac{W^2}{F^2 r^2 (2 - \frac{r}{R})^2}} \text{-----} \text{Eq. 22}$$

For cycloidal gears, Eq. (20) solved for "S":

$$S = \sqrt[3]{\frac{18}{32} \frac{CE}{E+E} \frac{W^2}{F^2 r^2 (2 + \frac{r}{R})^2}} = .8255 \sqrt[3]{\frac{CE}{E+E} \frac{W^2}{F^2 r^2 (2 + \frac{r}{R})^2}} \text{-----} \text{Eq. 23}$$

In the involute system, when the driver is smaller than the driven, the arc of approach presents the worst condition since the smaller flank of the pinion contacts with the face radius of the gear, whereas in the arc of recession the larger flank radius of the gear contacts with the face radius of pinion.

When the driver is larger than the driven the reverse is true.

For the cycloidal system the order is exactly reversed, in the first instance the arc of recession controls, and in the latter instance the arc of approach controls.

As for the bearing value of "K" there is very little experimental data on hand to select from. The best way to ascertain the value of "K" is to inspect a pair of existing gears that are known to have given good service, by applying Eq. (21) or (22) and find the value of "S", then apply Eq. (5) to find the value of "K".

The value of "K" cannot be judged by the safe or abrasive pressure on sliding surfaces. Take for instance a roller and slide it transverse to its axis on a flat plate, the surface will abrade under a certain load or contact pressure. Repeat the operation and give the roller a rotary motion simultaneously with its sliding motion, the rotation being in the direction of travel, and it will be found that a far greater contact pressure is required to produce abrasion.

Safe allowable values of "K" at a pitch circle speed of 100 feet per minute, based on experimentally determined values of "W" for good service, for involute teeth only.



The value of "K" is calculated for two meshing pinions of 12 teeth each and of the same material, and for  $p = 1$ ,  $F = 1$ ,  $R = r = .8$ .

TABLE I.

| Materials                            | E                 | Per 1" Cir. Pitch<br>W<br>Per In. Face | K      | S      |
|--------------------------------------|-------------------|----------------------------------------|--------|--------|
| Steel casting not heat treated ..... | $3 \times 10^7$   | 530                                    | 10,300 | 15,470 |
| Cast iron — good quality .....       | $17 \times 10^6$  | 320                                    | 7,100  | 10,660 |
| Phosphor bronze ...                  | $14 \times 10^6$  | 460                                    | 7,280  | 10,920 |
| Gun metal .....                      | $135 \times 10^6$ | 400                                    | 6,550  | 9,830  |
| High carbon steel...                 | $3 \times 10^7$   | 720                                    | 12,650 | 18,980 |
| Cast brass .....                     | $9 \times 10^6$   | 240                                    | 4,050  | 6,100  |
| High carbon steel...                 | $3.6 \times 10^7$ | 720                                    | 13,430 | 20,140 |

The coefficient of wear is some function of the product of "K" and the rubbing speed of the teeth, reduced to a value per tooth. If a 12-tooth pinion meshes with a gear of 48 teeth, then the coefficient of wear would be four times greater for the pinion than for the gear, when both are made of the same material.

Let  $C_g$  be the coefficient of wear, and "N" the number of teeth in the gear or pinion,  $V_p$  the rubbing speed of the teeth in feet per minute. Then:

$$V_r = .1 \pi p (k.p.m + R.P.M.) = .1 p V \left( \frac{1}{d} + \frac{1}{d'} \right) \text{---} \text{Eq. (26)}$$

$$or \text{---} V_r = 3.77 V \left( \frac{1}{N} + \frac{1}{n} \right) \text{---} \text{Eq. (27)}$$

$V$  = pitch circle speed, feet per minute.

$D$  = pitch diameter of gear in feet.

$d$  = pitch diameter of pinion in feet.

$$C_g = \frac{K^x V_r^y}{N} \text{---} \text{Eq. (28)}$$

The exponents "X" and "Y" vary with the conditions of the gears, whether they run dry, occasionally lubricated, dipping in oil, or forcing oil on the mesh line.

The data obtainable to determine the values of "X" and "Y" to approach practice, are totally inadequate. In nearly all cases the properties of the materials used are lacking. The following values of "X" and "Y", derived by inductive reasoning should not be far from representing practical results.

"a"—Dry gears,  $X = 1$ ,  $Y = \frac{3}{4}$ . "a"—Represents very light service, such as hand cranes, winches, etc.

"b"—Gears occasionally lubricated,  $X = 1$ ,  $Y = \frac{1}{2}$ . "b"—Represents the majority of cases, as, power cranes, lathes, locomotive cranes, traveling bridges, and the greater part of geared mill machinery, hoisting engines.

"c"—Gears dipping in oil (dust protected),  $X = \frac{3}{4}$ ,  $Y = \frac{1}{2}$ . "c"—Represents heavy mill service, as rolling mill drives, etc., pitch circle speeds up to 2,500 feet per minute.

"d"—Gears oil forced on mesh line,  $X = \frac{1}{2}$ ,  $Y = \frac{1}{2}$ . "d"—Represents high speed gearing up to 7,000 feet per minute pitch circle speeds, such as turbine reductions, etc.

For dry gears:

$$\frac{K V_r^{\frac{3}{4}}}{N} = C_g = 19500 b. \text{---} \text{Eq. (29)}$$

Where "b" is a factor of material used:

|                             |            |
|-----------------------------|------------|
| For steel casting .....     | $b = 1$    |
| For cast iron .....         | $b = 0.69$ |
| For phosphorous bronze ...  | $b = 0.71$ |
| For gun metal .....         | $b = 0.64$ |
| For cast brass .....        | $b = 0.4$  |
| For high carbon steel ..... | $b = 1.23$ |

For gears occasionally lubricated:

$$\frac{K^x \sqrt{V_r}}{N} = C_g = 6,900 b. \text{---} \text{Eq. (27)}$$

The value of "b" is the same as for dry gears.

Gears dipping in oil:

$$\frac{K^{\frac{3}{4}} V_r^{\frac{1}{2}}}{N} = C_g \text{---} \text{Eq. (28)}$$

|                             |             |
|-----------------------------|-------------|
| For steel castings .....    | $C_g = 690$ |
| For cast iron .....         | $C_g = 517$ |
| For phosphorus bronze ...   | $C_g = 528$ |
| For gun metal .....         | $C_g = 485$ |
| For cast brass .....        | $C_g = 339$ |
| For high carbon steel ..... | $C_g = 793$ |

Gears having oil forced on mesh line:

$$\frac{\sqrt{K V_r}}{N} = C_g \text{---} \text{Eq. (29)}$$

|                             |            |
|-----------------------------|------------|
| For steel castings .....    | $C_g = 68$ |
| For cast iron .....         | $C_g = 56$ |
| For phosphorus bronze ...   | $C_g = 57$ |
| For gun metal .....         | $C_g = 54$ |
| For cast brass .....        | $C_g = 42$ |
| For high carbon steel ..... | $C_g = 75$ |

(To be continued)

### New Manual Contactor

The CR-1049 manual contactor recently placed on the market by the General Electric Company is a new motor-circuit switch for easily disconnecting both motor and control from the line under practically all conditions except a dead short circuit. It consists of contact elements mounted on insulated shafts and connected through a snap-action mechanism to the operating handle on the outside of a sheet-steel enclosing case.

Both case and handle can be locked in the open position, thus preventing unauthorized persons from closing the device. No provision is made for locking the handle in the closed position, since the contactor will open the load with full safety to the operator. Silver contact tips are used on all sizes with the exception of the 50-ampere, thus cutting down the contact resistance.

The new contactor is being made in four sizes, as follows:

|                                            |
|--------------------------------------------|
| CR-1049-B2, 50 amperes, 3 poles.           |
| CR-1049-B2, 80 amperes, 2, 3 and 4 poles.  |
| CR-1049-C1, 150 amperes, 2, 3 and 4 poles. |
| CR-1049-D1, 300 amperes, 2 and 3 poles.    |

In designing the enclosing cases, consideration was given to space required for making soldered connections, to aid those who will install these contactors.

# The Occurrence of Alkali Cyanides in the Iron Blast Furnace\*

By S. P. KINNEY and E. W. GUERNSEY§

THE occurrence of alkali cyanides in the iron blast furnace has a twofold interest. First, the formation of these compounds through the fixation of atmospheric nitrogen is going on continuously during the normal operation of the hundreds of furnaces throughout the country, and the question naturally arises whether it would not be feasible to recover this fixed nitrogen either as cyanides or in other useful forms. Second, the alkali cyanides have been considered by some writers to have an important influence on the production of iron by the furnace, being regarded from some points of view as beneficial, and from others as harmful.

## Historical.

The presence of alkali cyanides in the blast furnace was first discovered about 1835, and in the literature of that period there are numerous references to analyses of excrescences containing cyanide which formed about the water-cooled bosh of various furnaces. Quantitative measurements were made about 1845 by Bunsen and Playfair† and later by Lowthian Bell,‡ in both cases by drilling a hole through the side of the furnace and determining the quantity of cyanide issuing with a measured volume of gas. Bunsen and Playfair reported a concentration of 8 to 10 grams of potassium cyanide per cubic meter at a point 0.69 meters (2 feet 3 inches) above the tuyeres, while Bell found on different occasions and on different furnaces 10 to 75 grams per cubic meter in the same region of the furnace. Some data have recently been reported by Franchot on gases issuing from the slag notch in which he found on the average about 145 grams per cubic meter. Interest in the subject at the present time is evidenced by the number of patents that have been taken out in recent years on the recovery of cyanides as a by-product of the blast furnace as well as on the adaptation of the blast furnace to the primary production of cyanides.¶

## Maximum Amount of Fixed Nitrogen Recoverable.

If cyanides were to be recovered as by-products of the operation of the iron blast furnace, a maximum limit to the amount recoverable is fixed by the quantity of alkali ( $\text{Na}_2\text{O}$  and  $\text{K}_2\text{O}$ ) contained in the raw materials fed to the furnace. According to a survey by the Bureau of Soils, a total of 222,900 tons of  $\text{K}_2\text{O}$  enters the blast furnaces of the country each year. This is equivalent to 308,000 tons of potassium

cyanide or 60,000 tons of nitrogen per year. No corresponding statistics are available for  $\text{Na}_2\text{O}$ , but the amount is doubtlessly considerably less. Since, at best, only a comparatively small fraction of the total alkali fed could be economically recovered as cyanide, it is evident that the amount of fixed nitrogen which might be obtained from blast furnaces operated on the present charges would be very small as compared with the total fixed nitrogen consumption of the United States, which is more than 200,000 tons per year at

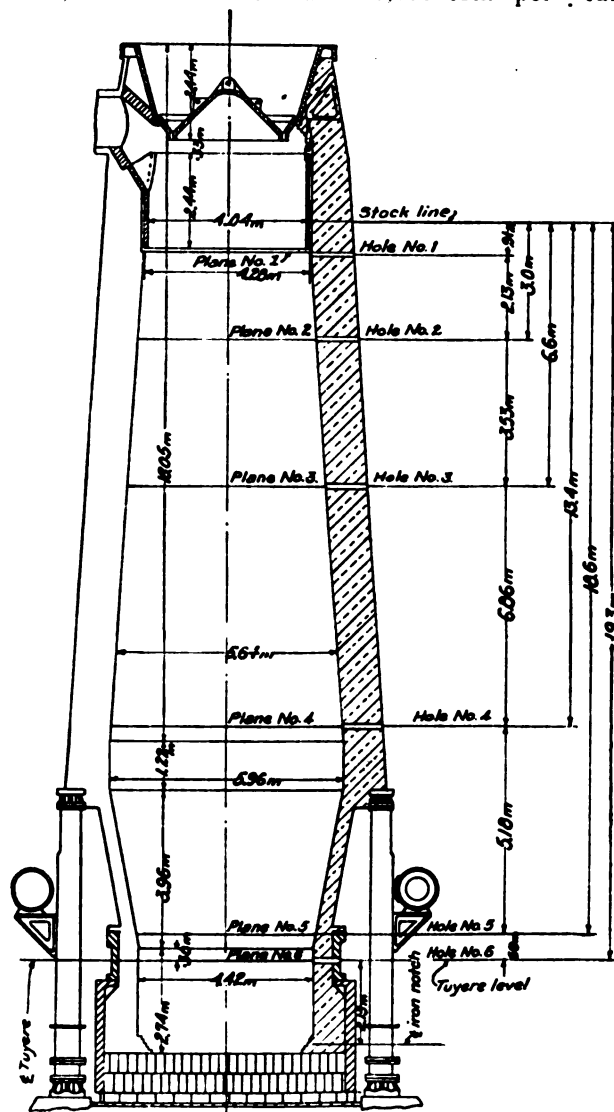


FIG. 1. — Cross-section, with dimensions of furnace.

the present time. If, however, even a small fraction of the maximum possible cyanide were recovered, the product might go far toward supplying the requirement for cyanides which is now approximately 20,000 tons ( $\text{NaCN}$ ) per year. The blast furnace might even become an important source of fixed nitrogen for general purposes, if it should be found feasible deliberately to increase the alkali content of the charge for the

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§Bureau of Mines and Fixed Nitrogen Research Laboratory, Washington, D. C.

†British Association Advancement Sci., Rpts., 1945, p. 142.

‡"Chemical Phenomena of Iron Smelting," 1872; "Principles of the Manufacture of Iron and Steel," 1884.

¶Addie, Cunningham, and McFarlane, British Patent 12,572 (1893); Sieperman, British Patent 13,754 (1898); Craig, U. S. Patent 600,137 (1898); McElroy and Spencer, U. S. Patent 1,156,108 (1915); Meadows, U. S. Patent 1,292,937 (1919); Weaver and Gayley, U. S. Patent 1,322,038 (1919); Haslup, U. S. Patent 1,310,478-79-80 (1919); McElroy, U. S. Patent 1,390,533 (1919); 1,466,624-5-6 (1919).



purpose of increasing the amount of cyanide recoverable. Although we are not now in a position to determine the practicability of such a procedure, the appraisal of this possibility will be aided by any knowledge we may gain as to the zone of formation, concentration, and behavior of cyanides in the furnace under normal conditions.

### Theory of Formation and Accumulation of Cyanides.

The average percentage of alkali in the raw materials entering the blast furnace is quite low—0.2 to 0.5 per cent. The concentration of alkali cyanides within the furnace may, however, become considerable by a process of accumulation. At some point in the furnace the temperature becomes high enough so that the alkali oxide is displaced by lime from the complex silicates in which it enters the furnace. This alkali oxide reacts with carbon and nitrogen to form cyanide, which, at the temperatures involved, must be entirely in the vapor phase. In general, the cyanides do not reach the top and escape with the gases, but are converted through reaction with the charge and with carbon monoxide and carbon dioxide of the gases to

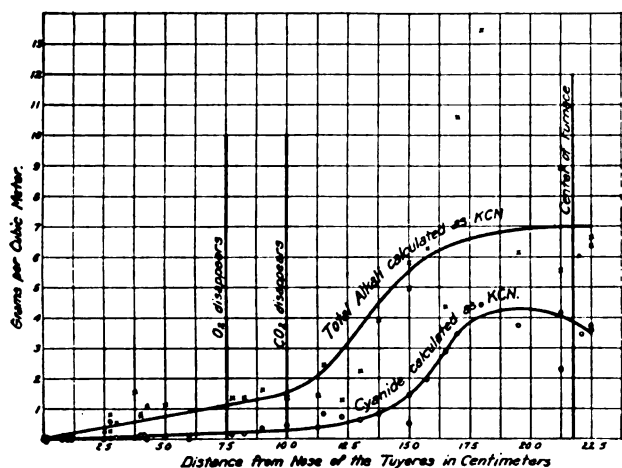


FIG. 2. — Cyanide and alkali in gases of the tuyere plane.

sodium silicate or to sodium carbonate, which is deposited and carried down with the stock to the region where the cyanide is again formed. A certain portion of alkali always goes through into the slag and a smaller portion escapes with the top gases. The sum of these two becomes, of course, equal to the alkali charged after the concentrations have reached fixed values by the above process of accumulation. The conditions within the furnace are too complicated to permit of a prediction in advance of actual measurement as to just where the maximum concentrations should be formed and what these concentrations should be.

### Experimental.

The accompanying data are the results of a large number of determinations on a furnace of the Central Iron & Coal Company at Holt, Ala., in normal operation producing about 300 tons of foundry iron per day. The determinations of cyanide concentration were obtained in conjunction with an extended investigation of the gas composition throughout the interior of the furnace. The data here reported differ from all previous determinations of which we are aware, in an important respect—namely, that the gas samples were

drawn from points in the interior of the furnace as well as at the wall. It has been found in this investigation that at certain levels in the furnace the concentration of cyanides in the interior is quite different from that at the wall.

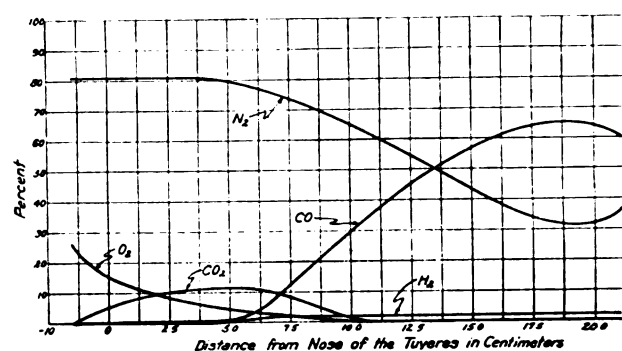


FIG. 3. — Gas analysis in the tuyere plane.

Fig. 1 shows the dimensions of the furnace on which the determinations were made, and the location of the holes in the furnace wall through which the gas and cyanide samples were taken.

### Apparatus and Method.

The water-cooled sampling tube employed has been previously described. It was 5.08 cm. (2 inches) o. d., 0.95 cm. (3/8 inch) i. d., and usually 5.2 meters (17 feet) in length, though shorter tubes were used in some experiments. In obtaining samples, the procedure was first to drive the sample tube to the center of the furnace, preventing the plugging of the tube with slag by blowing compressed air through it until ready to collect samples. The gas was then allowed to blow through the tube, and the fume resulting from the condensation of the vapor of alkaline compounds was collected by a paper filter thimble (such as used in the Soxhlet extractor) in a suitable holder. The volume of gas filtered was determined by a dry gas meter following the filter. The filter was leached with water and determinations were made of the amount of cyan-

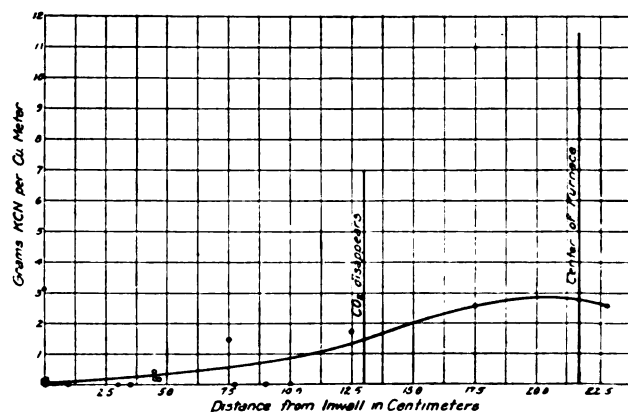


FIG. 4. — Cyanide in gases of the plane 0.7 meter above the tuyeres.

ide in the water solution, using the Lundell-Bridgeman method, and of total alkalinity by titration with standard sulphuric acid. When an ordinary gas analysis was desired, the issuing gas was collected over mercury. A study was made of the chief sources of error in the method of sampling furnace gases for alkali cyanides, and the conclusion was reached that the results obtained should in general be correct to

TABLE I — ALKALI IN BLAST FURNACE RAW MATERIALS AND PRODUCTS

|                                                | Brown ore | Attela red ore | Estelle red ore | Nodules | Limestone | Coke | Total |
|------------------------------------------------|-----------|----------------|-----------------|---------|-----------|------|-------|
| Per cent Na <sub>2</sub> O.....                | 0.30      | 0.30           | 0.50            | 0.2     | 0.0       | 0.06 |       |
| Per cent K <sub>2</sub> O.....                 | 0.30      | 0.80           | 0.60            | 0.3     | 0.0       | 0.17 |       |
| Kg. Na <sub>2</sub> O per metric ton iron..... | 2.83      | 0.86           | 0.98            | 0.89    | 0.0       | 0.71 | 6.27  |
| Kg. K <sub>2</sub> O per metric ton iron.....  | 2.83      | 2.30           | 1.18            | 1.36    | 0.0       | 2.00 | 9.67  |
|                                                | 5.66      | 3.16           | 2.16            | 2.25    | 0.0       | 2.71 | 15.94 |

within 10 per cent. The error might, however, be considerably greater if samples were taken at such a point in the furnace that the alkali compounds were present as a fume rather than as vapor.

Results—Alkali In Raw Materials.

Complete analyses were made on composite samples of all raw materials fed to the blast furnace and on the slag and flue dust. Table I shows the alkali content of the raw materials.

The total alkali fed into the furnace was thus 15.94 kg. of K<sub>2</sub>O and Na<sub>2</sub>O, equivalent to 19.2 kg. of K<sub>2</sub>O

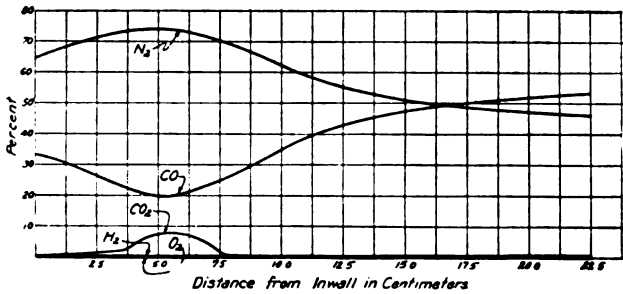


FIG. 5. — Gas analysis in the plane 0.7 meter above the tuyeres.

per metric ton (43 pounds per long ton) of metal produced. The total charge per metric ton of metal was 3945 kg. The average alkali content was therefore equivalent to 0.51 per cent K<sub>2</sub>O. The analysis of the furnace products indicates that almost three-fourths of this alkali leaves the furnace in the slag, while the remainder passes out with the top gases and collects in the dust catcher and in the stove dust.

Alkali and Cyanide Concentration in Gases at Different Parts in the Furnace.

In all, 23 determinations of cyanide concentration were obtained in plane 4, 5.9 meters (19 feet 3 inches) above the tuyeres, 19 in plane 5, 0.7 meter (2 feet 3 inches) above the tuyeres and 38 in plane 6, at the tuyere level. For the samples in the tuyere plane, the sample tube was inserted through an opening in a specially designed tuyere cap in the usual position of the sight glass, and so through the nose of the tuyere, samples being taken with the normal blast passing through this tuyere.

The concentration of alkali cyanide (calculated as KCN) found at these three planes is shown in Figs. 2, 4, and 6, and the corresponding gas analysis results are shown in Figs. 3, 5, and 7. Although the individual results varied widely, certain general trends in the results are well marked. In both tuyere plane and plane 5 the concentration of cyanide increases markedly toward the center of the furnace, the actual amounts varying from practically zero at the wall to a value at the center of about 4 grams per cubic meter in the tuyere plane, and 3 grams in plane 5. As shown in Fig. 2 for the tuyere plane, the total alkali also dimin-

ishes rapidly toward the outside of the furnace. The total alkali concentration does not, however, diminish so rapidly as that of the cyanide. That is, there is a relatively larger portion of the alkali in forms other than cyanide near the wall, due, no doubt, to the oxidizing conditions in this region. It will be noticed that beyond about 100 cm. (40 inches) from the wall, where oxygen and carbon dioxide have disappeared (Fig. 3), there is a much larger portion of the alkali as cyanide. The proportion of alkali as cyanide also appears to increase toward the center in plane 5, but owing to the smaller number of experiments, the trend is not so well marked as in the tuyere plane results. At plane 4 the concentration is much more nearly constant at varying distances from the wall, and the results were less variable than at the other planes. The cyanide concentration in this plane is about 3 to 3.5 grams of potassium cyanide per cubic meter. Total alkali determinations were not made in all cases, but the percentage of the total alkali that was combined as cyanide varied from 41 to 96 with an average value of 66 per cent.

A number of samples from the slag notch were examined with quite variable results, as Table II shows. The samples were taken just after the metal was cast. For these samples, an iron pipe was forced against the outside of the slag tap hole and the gases were taken as they blew from the furnace, instead of by the usual procedure of inserting the sample tube inside the furnace.

TABLE II — CYANIDE AND ALKALI IN GAS FROM SLAG NOTCH

| Volume Cu. m. | Total alkali Grams/cu. m. calcd. as KCN | Cyanide Grams/cu. m. calcd. as KCN | Per cent alkali as cyanide | Remarks                                                      |
|---------------|-----------------------------------------|------------------------------------|----------------------------|--------------------------------------------------------------|
| 0.019         | 883                                     | 558                                | 63                         | Tuyere above slag notch closed. Sample 66 per cent KCN       |
| 0.038         | 152                                     | 56.5                               | 37                         | Tuyere above slag notch closed. Gas pressure 5 pounds        |
| 0.80          | 11.6                                    | 9.54                               | 82                         | Tuyere above slag notch in operation. Sample 72 per cent KCN |
| 0.6(est)      | 20.4                                    | 19.0                               | 93                         | Sample 47 per cent KCN                                       |
| 0.31          | 23.6                                    | 0*                                 | 63                         |                                                              |
| 0.38          | 3.26                                    | 0.99                               | 30                         |                                                              |
| 0.060         | 23.0                                    | 14.82                              | 64                         |                                                              |
| 0.045         | 14.8                                    | 10.93                              | 74                         |                                                              |

\*Titration one drop only; cyanide less than 0.053 gram per cubic meter.

From the volume of top gas and the amount and analysis of flue dust, it is calculated that the top gases should contain about 0.9 gram of total alkali (calcu-



lated as KCN) per cubic meter. It appeared from an examination of the wash water from the wet dust catcher before and after furnace slips that the elimination of alkali through the top took place largely during these slips. Hence, actual analyses of the top gas for alkali fume, which were all made during quiet operation, gave much lower results.

Analysis of Fume Samples.

Numerous samples of fume have been collected from the gases issuing at hole 4 and at the slag notch. In Table III is given an analysis of a portion of a fairly large sample of fume obtained at hole 4 in a collection apparatus capable of removing fume from about 5.7 cubic meters (200 cubic feet) of gas per minute.

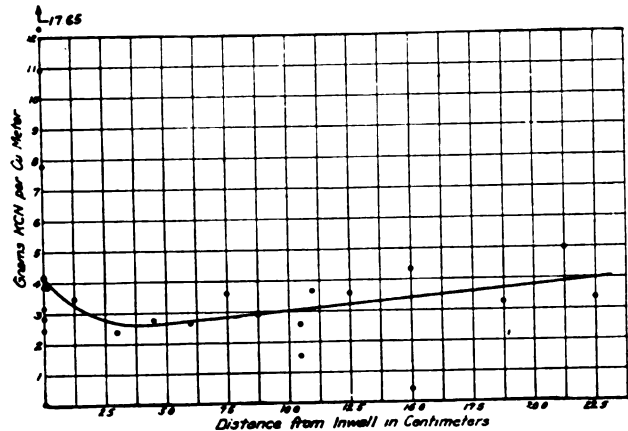


FIG. 6. — Cyanide in gases of the plane 5.9 meters above the tuyeres.

For comparison there is shown also an analysis of a sample of fume collected at the slag notch.

TABLE III — ANALYSIS OF FUME SAMPLES\*

|                                 | Fume from Hole 4<br>5.9 Meters above Tuyeres |                                          | Fume from Slag Notch                   |                                          |
|---------------------------------|----------------------------------------------|------------------------------------------|----------------------------------------|------------------------------------------|
|                                 | Water-solu-<br>ble portion<br>Per cent       | Water-insolu-<br>ble portion<br>Per cent | Water-solu-<br>ble portion<br>Per cent | Water-insolu-<br>ble portion<br>Per cent |
| KCN                             | 31.32                                        |                                          | 46.4                                   |                                          |
| K <sub>2</sub> CO <sub>3</sub>  | 24.60                                        |                                          |                                        |                                          |
| NaCN                            |                                              |                                          | 13.8                                   |                                          |
| Na <sub>2</sub> CO <sub>3</sub> | 1.24                                         |                                          | 4.0                                    |                                          |
| SiO <sub>2</sub>                | 0.0                                          | 0.98                                     | 0.16                                   | 1.00                                     |
| PbO                             |                                              | 12.30                                    | 0.0                                    | 0.0                                      |
| FeO                             | 0.50                                         | 2.28                                     | 1.08                                   | 0.69                                     |
| Al <sub>2</sub> O <sub>3</sub>  | 0.14                                         | 1.55                                     | 0.38                                   | 0.42                                     |
| ZnO                             | 13.18                                        | 4.71                                     | 5.43                                   | 2.49                                     |
| CaO                             | 0.57                                         | 0.65                                     | 0.46                                   | 0.24                                     |
| MgO                             | 3.08                                         | 0.01                                     | 0.97                                   | 0.03                                     |
| K <sub>2</sub> O                | ...                                          | 1.02                                     | ...                                    | 0.29                                     |
| Na <sub>2</sub> O               | ...                                          | 0.58                                     | ...                                    | 0.10                                     |

The fume from the slag notch appears to differ from that from hole 4, chiefly (1) in the absence of lead, and (2) the much lower amounts of zinc. The higher percentage of alkali which is combined as cyanide as shown in this sample from the slag notch is not typical of fumes at this point. As shown in Table II, the total water-soluble alkali which is combined as cyanide varies from 37 to 93 per cent. It is of interest to note that in all samples of fume analyzed there is very much more potassium than sodium, though in the original charge they are present in about equivalent amounts. In other words, the tendency of the potassium compounds to volatilize and circulate in the furnace is much greater than that

tendency for sodium compounds, which is in accord with the known greater volatility of compounds of potassium.

Discussion.

The results obtained in this investigation differ from those of Bunsen and Playfair and of Lowthian Bell in two ways. In the first place, the amounts found were much smaller, varying from 0 to 4 grams per cubic meter for the section of furnace just above the tuyere plane, as compared with Bunsen's 8 to 10 grams and Bell's 10 to 75 grams per cubic meter in the same region. As a tentative explanation of this difference, it is suggested that the method of sampling employed by the earlier investigators might easily have given high results. The sample was taken by opening the outside of a hole through the wall and allowing the fume to emerge, and it is quite possible that considerable amounts of cyanide deposited in the sample hole previous to sampling and were carried out with the gas sample and erroneously considered as having been contained in the measured gas inside the furnace. It is believed that some of the high results found in this investigation at the slag notch, at which point the sampling was similar to that used by the earlier investigators, may possibly be due to an error of this sort.

A second point in which these results differ from those of Bell is that he found the concentrations to in-

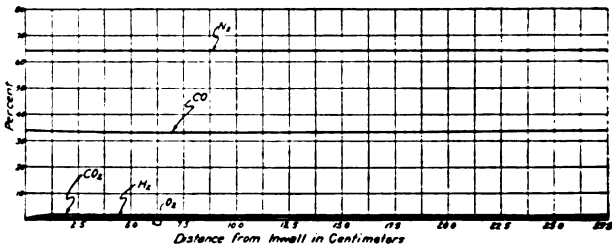


FIG. 7. — Gas analysis in the plane 5.9 meters above the tuyeres.

crease continuously toward the lower levels of the furnace, whereas the present writers found higher concentration at plane 4 than at the tuyere level.

Of all the planes of the furnace where samples were obtained the maximum amount of cyanide appears to be passing plane 4. The high concentrations at planes 5 and 6 near the center of the furnace and at the slag notch do not indicate large amounts of cyanide, since the gas flow through these sections is relatively small as we know from other evidence. The writers have, of course, not necessarily located the region of maximum concentration. It may only be said that the maximum occurs somewhere between plane 5 and plane 3, the latter being 12.7 meters (41 feet 9 inches) above the tuyeres.

It is of interest to consider what amount of alkali cyanides we might hope to recover from such a furnace as the one studied. Let us suppose that gas is withdrawn at plane 4. The cyanide concentration at this plane is roughly 3.5 grams per cubic meter. The volume of gases passing is roughly 1570 cubic meters (55,000 cubic feet) per minute. We do not know what portion of this gas may be withdrawn without interfering with the reduction of iron oxide in the shaft, but the excess of carbon monoxide is known to be considerable, and we may safely assume that one-tenth, or 157 cubic meters (5500 cubic feet) per



minute, may be withdrawn. The amount of cyanide carried by this gas would be 
$$\frac{157 \times 60 \times 24 \times 3.5}{1000}$$

= 792 kg. (1745 pounds) per day, calculated as KCN, provided the concentration of cyanide remained constant on continuous withdrawal. This concentration would, of course, drop somewhat on continuous withdrawal. A calculation has been made on this point based on the relative amount of alkali in the gas, most of which is condensed and carried back in the stock, and the amount coming down with fresh charge. From this calculation it appears that the concentration would not be lowered more than about 13 per cent by the withdrawal of one-tenth of the gas, making the daily recovery 690 kg. of potassium cyanide. Assuming that the cyanide represents only 6.0 per cent of the total alkali in this gas, the alkali withdrawn would be 15 per cent of the total charged. Assuming a value of 10 cents per pound for the potassium cyanide in this crude product, the value would be about \$150 per day, as compared with about \$5,000 for the metal. It seems probable that considerably more than one-tenth of the gas could be withdrawn, when the value of the product would be correspondingly higher.

Cyanides in the blast furnace have been considered harmful from two points of view—namely, that the furnace lining is deteriorated by the action of the volatile alkali compounds, and that the fuel economy of the furnace is lowered by the distillation of the cyanides from the hearth. From these points of view the removal of cyanides would aid rather than interfere with the production of iron. In earlier years the cyanides were regarded as acting as indispensable reducing agents for the final reduction of iron, but this view is not now generally held. In any case, the removal of a small portion of gas from a furnace in which the conditions are such as found in this investigation will not greatly change the alkali concentration inside the furnace. Regarding the effect of the distillation of cyanide in the furnace, it must be said that the amounts of cyanides which have thus far been found in circulation are too small to affect significantly the fuel economy of the furnace.

It is planned to carry out investigations similar to the one here reported on blast furnaces in various sections of the country, in which furnace charges and operating conditions are different.

#### Acknowledgment.

The authors desire to express their indebtedness to the Central Iron & Coal Company, whose co-operation and assistance made this investigation possible. They wish to express in particular their appreciation of the interest and active co-operation of Fraser B. McKenzie, blast furnace superintendent, and J. L. Brierton, vice president and general manager.

The Central Furnace Company, Massillon, Ohio, operated by the Central Steel Company, has active construction in progress on its new blast furnace and expects to have the stack ready to blow in by the first of the year. The stoves and other primary features are now in progress. The unit will be devoted to the production of pig iron and will develop a considerable increase in the present tonnage rating of the company.

#### H. F. Wahr New Mesta President

Prepared to carry on the well established policies of the Mesta Machine Company, Mr. Harry F. Wahr, formerly vice president, was elected president, succeeding the late Frederick E. Mesta to the leadership of this company.

Mr. Wahr was born in Pittsburgh, Pa., in 1884, and received his education in the Knox Public School, the Park Institute and the Western University of Pennsylvania, now the University of Pittsburgh, and was graduated from this institution, receiving the degree of mechanical engineer, in 1903.

After completing his education, Mr. Wahr became associated with the Mesta Machine Company, and for a number of years was connected with the engineering



HARRY F. WAHR

and metallurgical departments, and later was made secretary and sales manager. When Mr. Frederick E. Mesta succeeded his brother as president, Mr. Wahr was made vice president.

Mr. Wahr's long association with the company has ably fitted him to assume the position of chief executive, and the business policies of this company, as established by his predecessors, George Mesta, founder of the company, and the late Frederick E. Mesta, who made this prominent engineering institution a leader among the trade, will be continued.

Mr. J. O. Horning, in addition to continuing his present position as treasurer, was elected vice president.

Mr. Iversen, who will continue as chief engineer of the company, was elected vice president.

Mr. John Edwards was elected assistant treasurer.

Mrs. Pearl R. Mesta, widow of the late George Mesta, was elected to fill the vacancy on the Board of Directors, caused by the death of Frederick E. Mesta.



# THE SAFETY CRUSADE

## *How the Electrical Engineer and the Safety Engineer Can be Mutually Helpful\**

A Very Human Conception of the Vast Importance of the Close  
Co-operation upon Which the Whole Safety  
Movement Is Founded

By JOHN A. OARTEL†

THE application of electricity to modern industrial transportation and to general living conditions has truly been marvelous, and if advancement of this science during the next 50 years equals that of the last half century, I think we can truly say that we live in the age of miracles. We, who are here today, are particularly interested in one phase of electricity only, namely, its application to the iron and steel industry. I think there are a number of men in this gathering who can remember when the only use to which it was put in a steel mill was to furnish light of a very un-

ricated product in a railroad car ready for shipment to its destination.

The electrical engineer in the steel mill today is concerned not only with the continuous and efficient operation of a few isolated units, but with the continuous and efficient operation of the entire plant. If the "juice" fails, the mill goes down, and the electrical engineer is "out of luck." I desire to add another responsibility to his already burdened shoulders. To continuous efficient operation of the plant, I want to add—safe operation. American Industry has learned to its abiding credit that iron and steel can be produced efficiently, in great quantities and—safely. I need scarcely remind you that this organization was responsible for the beginnings of organized safety in this country. You fathered the National Safety Council, which is recognized as the chief promoter of safety, both industrial and public in this country. You now invite the safety engineers from the iron and steel mills to come into your organization in order that our common problems may be happily solved.

I shall not attempt to discuss any of the specific problems that confront the electrical and the safety engineer. I shall leave the detail to be worked out later by those who are better qualified. I shall only emphasize a few general principles, which, if applied, should help both the electrical and the safety engineer and which should bring them closer together in their work.

I had a very unique and helpful experience in safety about a year and a half ago, which made a lasting impression on me. I had the privilege of making a safety survey of ten large steel mills, employing approximately from one thousand to ten thousand men. By using the expression "safety survey," I do not use it in the generally accepted meaning of the term. As commonly understood it means to go into a plant and inspect for mechanical hazards or dangerous practices. I did not go into the plants at all. I went into the Superintendents' dining room at each plant and sat down to lunch with the General Superintendent and all his Department Superintendents and asked them—why in these days of advanced safety they were still having accidents in their particular plant. The answers were many and varied, and I shall not burden you with them in this address. I completed the survey, went back to my office and thought it all over. I then asked myself several questions. The questions



JOHN A. OARTEL

certain quantity and quality. I refer to the old-fashioned arc light. It may be that there is at least one person here whose duty it was to go around at night in a steel mill with a long pole and shake the carbons into renewed activity. What do we see now? We see electricity as the actuating principle in all our steel mill operations, beginning with the electrical car dumper and transfer car at the blast furnace and ending with the magnet that deposits the finished or fab-

\*Given before the 20th annual convention, A. I. & S. E. E.

†Chief of Safety Bureau, Carnegie Steel Company, Pittsburgh, Pa.

were: "Was it worth while?" "Have I learned anything?" and "Did it do any good?" After thinking it all over and having analyzed and visualized the organization at the various plants I had visited, as well as the methods they used and what was said at the meetings, I answered "yes," to all my questions, "it was worth while," "it did some good," and "I learned something."

I learned first, and it is not a new conception by any means, that it is a good thing for men to get together to discuss common problems. The dreadful ravages of war could be avoided; costly litigation could be prevented, and people would be very much more prosperous and happy, if the get together spirit prevailed more generally. I cannot announce definitely what the results of this meeting will be, but I think I can safely prophecy that a better spirit and a clearer understanding will prevail among the electrical and safety engineers from our iron and steel mills, just because we have come together around the council table to meet each other, to look into each other's faces and to solve our common problems.

Common problems lead directly to the next thing I learned in my survey which was, I found that the plant where the best co-operation prevailed, invariably had the best safety record. It was so very evident that I could lay my finger on it and say "Here it is." Co-operation is not a new term. It is as old as mankind. It means simply for people to help each other. It means that the man in the mill or in the office shall help his fellowman, and where the greatest co-operation prevails, there the greatest success is found. It is the spirit of the baseball team or the football team, where all individuality is subordinated in order that the team may win. It is the spirit of the college yell where thousands of young voices rend the air as one voice—to spur the team on to victory.

I recently saw this spirit exemplified to a marked degree in a safety drive in a large steel mill employing 6,500 men.

In preparing for the drive the safety director and myself visited every department to meet and talk with the department superintendent, the safety committee and groups of employes. I was particularly impressed with the very able manner with which the electrical superintendent handled the matter. He was not satisfied with anything less than complete co-operation with the safety director. It was not enough for him to bring the safety committee, the foreman and the gang leaders to the office to hear the talks—his ambition was to have his full force hear about the safety drive and to participate in it to the fullest possible extent. He had his entire force come to the electric shop in groups of fifty or a hundred. The shop was provided with seats in order to have the men comfortable during the talks. Safety bulletins, signs and slogans were displayed on the walls. Safety devices used in the electrical department were displayed and their use explained to the men. An orchestra was recruited from the men in the department, which entertained the men while they waited for the speakers. To sum it all up, it was one of the finest examples of co-operation that I have ever seen, and I take pleasure in stating that the electrical engineer, whose work I have been describing, is the President of this organization, Mr. A. C. Cummins. The Carnegie Steel Company has an enviable safety record.

That record is not due to the contribution of any one man alone. Mr. Burnett has given his leadership and counsel. I have tried to do my bit. The enthusiasm of the safety engineers at the plants has been remarkable. The burden and the heat of the day, however, has been borne by men in positions similar to that of Mr. Cummins, who have rallied to the work and who have given their whole hearted co-operation.

On the other hand, I wish to tell you of an incident in a steel mill in connection with electrical apparatus, where the lack of co-operation among a number of the men resulted in a fatality. The details of the accident are as follows:

Two narrow gauge engineers, working on the 3 to 11 turn, whose work was to transport hot billets through a tunnel, discovered that the warning whistle at the mouth of one end of the tunnel was not working. One of them had the Roller blow the whistle to call the electrician, who responded to the call and made an investigation. So far as he could see everything was all right at that end of the tunnel, and he asked one of the engineers to make sure on his next trip that the switch at the other end of the tunnel was all right. There was no further conversation between these two men during the remainder of the turn. At 11 p. m. two other engineers came on the job. One of these noted on his first trip through the tunnel that the whistle did not work. He took such steps as were necessary to call this to the attention of the electrician then on duty. About 2:30 a.m. the foreman of the mill noticed that the tunnel whistle was not working, and the electrician was again called. At that time the electrician who was called, said that the trouble was at the other end of the tunnel, but nothing further was done to put it into service. At 7 a. m. the turn changed again. The foreman had given the whistle no further thought, the engineer left the job without advising the man who relieved him that the tunnel whistle was not operating; the electrician also left the job without repairing it or reporting it to the night electrical foreman. About forty-five minutes later a narrow gauge engineer was on the tracks near the end of the tunnel when another engineer made his first trip through. The crew were depending on the whistle for a warning, as the whistle did not blow they assumed everything was all right. The engineer coming through the tunnel threw the tunnel switch as usual, and had no way of knowing that it was not working, there was a violent collision between the two engines in which a man was instantly killed.

I hesitate to say more about Mr. Cummins lest he become embarrassed. It is better, however, to have in your midst the man who has done the things I am advocating, than to create an ideal which is impractical. That is the reason I am going to say one thing more about him. He said to me, during the course of the meetings I have just described, "I am trying to instill the thought of service into the minds of my men. I am telling them they are the service department of the plant. I am trying to get them to understand that the continuous and successful operation of the plant depends on the character of the work they do." I think if the electrical men here could



take home the thought that their work is indeed a service to the entire plant, and if they could spread this among their men, this convention would, indeed, accomplish something worth while.

You as electrical engineers, are all familiar with the harnessing of Niagara. Some of the latent energy that has poured over the falls for ages is now doing useful work. My problem at this stage of my address is to turn the fine spirit of unity and co-operation into something useful down in our various steel plants. This brings me naturally to the last thing I discovered in my survey, which was, that the department doing the most intensive safety work, invariably had the best safety record. By intensive work I mean, the holding of department safety committee meetings; safety instruction by the foremen, either individually or in groups; alertness on the part of all to discover and eliminate dangerous practices — in fact, to do anything that can be done to promote safety.

Work is a term that has fallen into disrepute in late years. The only ambition of a great many people is to do as little work as possible; this is true not only in the steel mills, but also in offices, stores and everywhere business is transacted. While it is true that manual work has decreased, because of the application of science, nevertheless, there is still great need and great demand for men who will apply themselves to a given task. This is particularly true of the work of the electrical engineer and of the safety engineer. The electrical engineer is reaching out into the boundless and fathomless ether to find a vehicle to conduct the electron to its destination. Likewise, the safety engineer is delving into the inner workings of men's minds to find out the reason for accidents. The electrical and the safety engineer have both had marked success in their professions in recent years. While they have been close allies in their work, I hope this convention will mark the time when they shall not only be allies but co-workers, each helping the other by a closer co-operation and a better spirit to the achievement of a common aim—efficiency with safety. My earnest wish is that the inspiration and ideas we receive here may be an incentive to more earnest endeavor that will result in greater achievements in the days and weeks to come.

A short illustration in closing will perhaps sum up a few of the vital things I have endeavored to express to you. In a recent safety drive in a steel mill, it devolved on me to secure some speakers. I phoned to one of our plants to a department superintendent to get him to make the talks on one of the selected days. His talks were well received and were very successful. The day following the talks he held his own department safety committee meeting. When the minutes came to my office, I read a description of his experience, which he had given to his committee. He said, "Boys, it was my privilege yesterday to go to another plant to make some safety talks. It was necessary for me to get up at five o'clock in the morning in order to arrive at my destination on time. I made five talks and was very much impressed by the interest and enthusiasm in the safety drive, which was displayed at every meeting. I arrived at home at one o'clock in the morning, and I enjoyed every minute of the time." Surely if we can catch the spirit of this man it cannot fail to show results in our work.

### J. L. Jones Named Director of A. F. A.

Mr. Jesse L. Jones, in charge of the Chemical and Experimental Laboratory of the Westinghouse Electric & Manufacturing Company, has been named a Director of the American Foundrymen's Association and also appointed as chairman of the important Grey Iron Castings Committee. He is also a member of the building and equipment section of their General Foundries Committee, which is just now busy with the erection of a new half million dollar brass foundry.

Since 1903, Mr. Jones has been with the Westinghouse Electric & Manufacturing Company, in charge of chemical and physical testing work, which has been



J. L. JONES

largely related to the operations and products of their iron, steel, brass and malleable foundries. In connection with their other engineers, what is probably the largest and most complete privately owned reclaiming and smelting plant in the United States, has been developed also a copper refinery, copper rolling mill, die casting plant, etc.

Mr. Jones is a past-president of the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers.

# SHEET AND TIN PLATE

## Recuperation Offers Definite Savings

### Discussion of the Salient Characteristics of a Special Tile Recuperator

By E. R. POSNACK\*

**D**ESPITE very apparent benefits of recuperation, there prevails, among manufacturers, a noticeable lack of confidence in this method of heat recovery. Some are not convinced that it pays; others feel that it is too complicated; and many believe that there are certain defects, such as leakage and clogging of flues, that are inherently characteristic of all recuperators. In the figure shown, which presents a view of cross-section of special tile, and below an assembly of these tiles, it has been thoroughly demonstrated to the satisfaction of numerous authorities that the usual objections have been successfully overcome. A highly efficient, safe, simple and lasting construction has resulted.

As will be seen from the accompanying illustrations, this system comprises an arrangement of standardized units, each of which is a hollow tile containing a curved passageway beginning and terminating in one surface, the joints being rabbeted. These are assembled so as to form two independent sets of flues. Through one of these, namely the straight horizontal, the products of combustion pass, and through the other set, composed of a series of sinuous flues, the air required for combustion courses. The tile are so arranged as to make all the joints horizontal. Baffles are used to provide the air and gas with a sufficient number of passes, according to the requirements of each installation.

The dominant features of this design are as follows:

1. The horizontal, gravity-sealed, interlocking joints, prevent leakage. The weight of the superimposed parts bears down upon these joints, keeping them closed and rendering them self-sealing. Gravity is harnessed to serve as a sealing agent, and will not permit high pressure air or vibrating machinery to open the joints. This obviates the necessity of employing balanced draft methods.

2. Due to the sinuous air path, each tile presents a large surface of heat transmission per unit of weight or volume. This means that for a given recuperative effect, it is economical both as to space and material.

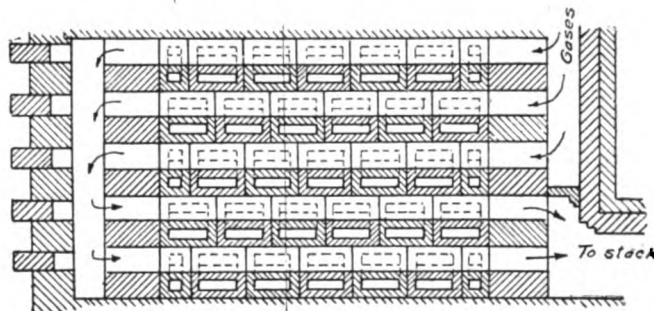
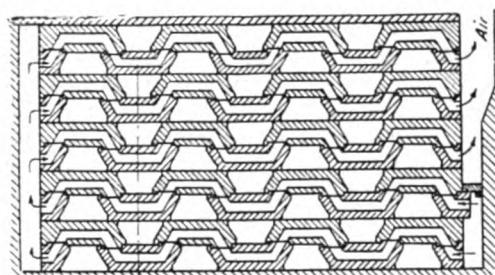
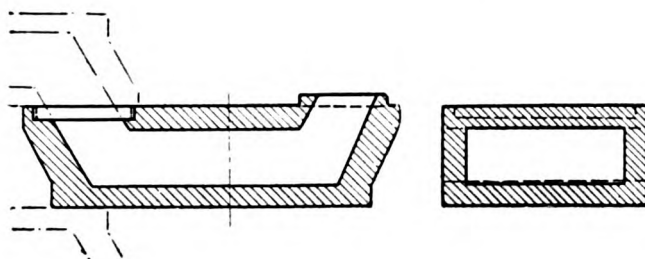
3. As the sides of the recuperator are free from the walls of the furnace, expansion is possible in all directions, thus preventing any undesirable stresses. The interlocking joints fit freely enough to permit a horizontal adjustment to take care of any expansion or contraction that might take place.

4. The baffles permit uniform velocities for both air and gas — a condition which is impossible where

one of the fluids courses upward in straight vertical flues.

5. The cooling of the tie on four sides by the incoming air results in a low mean temperature in the recuperator walls, thus insuring long life.

6. The air is made to course through in thin and flat streams, thus allowing a thorough penetration of heat.



POSNACK RECUPERATOR WITH TWO AIR AND TWO GAS PASSES

7. Plugs set in opposite each gas flue enable these flues to be inspected and cleaned without interfering with the operation of the furnace.

8. The recuperator walls are of uniform thickness, resulting in an even distribution of heat and reducing the danger of cracking of walls to a minimum.

(Continued on page 418.)

\*Mechanical Engineer, New York City.



# Discourse On Draught For Rolling Mill Furnaces

By WILLIAM LESTER\*

**I**T required the co-operation of consulting engineers and consulting chemists to prescribe air preheating mechanism, an improved form of combustion, as the most essential economizer in the rolling mill industry.

Draught or air supply for fires in rolling mill furnaces for the purpose of creating the different heats on iron or steel for the various kinds of iron or steel products as are manufactured in the industry today is one of great deficiency, and its improvement involves the greatest economic problem that confronts the industry.

In the past, when capacity and amount of work was less than one-half of what it is today, forced draught in the form of fan or steam for combustion purposes was not in vogue; but as capacity and output since then have increased from 100 to 300 per cent. it is compulsory to resort to forced draught in order to heat metal fast enough to keep workmen busy, and in this way of using forced draught mistakes and complications are created, namely, excess air used to create sufficient heat. The necessity of raising furnace doors very often, to charge and withdraw metal, adds to complicated heating process. The rapid escaping of heat in furnace with door or doors up serves as a siphon to draw excess air to compartments where metal is being heated.

As all furnaces are full of heat from top to bottom and the metal is always on the bottom of furnaces while being heated, it is therefore readily understood the bottom of a furnace is the coldest part, and as excess air used in forced draught floats on the bottom of a furnace, the results are an undesirable, uneven, hard, scaly or oxidizing heat on metal. This way of operating the furnace which is in vogue today requires long experienced furnace men, with results which can be very much improved to the extent of eliminating the causes of complications and difficulties, thereby simplifying acquirement of desirable results and eliminating the necessity of long experienced men to successfully do the work. By using hot draught instead of cold draught, the rolling process would likewise be simplified. Hot draught would be supplied by air preheating mechanism.

## Cold Draught—Sheet-Tin Mills.

With this cold draught system of today, when the required temperature for heating metal is acquired, the roof of a furnace is hundreds of degrees temperature hotter than the bottom where metal is. This often results in roof melting slowly in the form of what is called "drip," and this drip falls on metal below as it is being heated and adheres to metal, causing ugly destructive streaks on the metal after being rolled into any kind of product. The scale created gives unsatisfactory results on account of rough surface when the smoothest possible surface is required. There is a lack of uniformity of heat, which uniformity is so essential in rolling process in addition to hard

heat, and this greatly complicates the work for the workmen that much waste is made, more work required and the general results inferior. The effects on furnaces are very destructive. A very dirty furnace causes dirt to get into the metal. What is called clinkering is so great in many instances that work must be stopped to clean the furnace.

This cold draught is too deficient for combustion purposes with the following results on furnaces: Dirty furnace, destruction of furnace, clinkers, excessive consumption of fuel, hard scaly heat, uneven heat, which makes hard and complicated work for skilled furnacemen or heaters. The following are the effects on rolling process: The rolls are pitted or roughened, requiring polishers at frequent intervals to keep them smooth without satisfactory results. Many stickers are made in addition to pinched and jumped sheets. Two to three per cent excess scrap is caused on account of uneven heat. Pinched sheets are caused by excessive application of screws on metal in rolling process, usually caused by imperfect heat. Jumping or lapover is caused by metal not setting, adhering or rolling solid like one sheet when two or more sheets in a bundle are rolled at once. The parts of a sheet or sheets in this bundle that will not adhere tightly together after passing through the rolls, the loose parts or part will jump or lap over or fold if entered through rolls again without opening loosened sheets to and beyond parts or part that were opened or loose. Rolls are frequently broken. Much more motor power is required to draw metal through rolls and wears the rolls, screws, boxings and housings of mills to impairment conditions very quickly. The numerous complications retard the progress of the workmen at least 25 per cent capacity, not mentioning inferior results as to quality of marketable sheets.

This form of draught for combustion purposes for rolling mills is deficient, complicated and destructive in its function, causing very many millions of dollars worth of waste or loss annually in the American iron and steel industry, which could be saved by using air preheating mechanism.

Hot draft through an air preheater would improve all this.

The following is an example of a practical air-heater:

A fire brick box with outside dimensions 56 in. long, 39 in. wide and 33 in. high and the wall 8 in. thick. The top and bottom to be open to permit escaping flames, gases, and smoke of flues to furnace to enter bottom of preheater and out at top of preheater into stack of furnace. There would be 10 nichrome steel tubes, 40 in. long, effective heating length, and 4 in. in diameter running lengthways of fire brick box and opening on the outside at each end, one end being imbedded in brick wall while the other end is free to slide in short length tubes imbedded in the other wall and packed airtight with asbestos to prevent escape of air into stack. The short length

(Continued on page 417.)

\*Sheet roller of nearly 30 years' rolling mill experience.

# CURRENT REVIEW

## Current Literature on Ferrous Metallurgy

By E. H. McCLELLAND\*

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Discusses failure of short anneal. H. A. Schwartz. *Foundry*, v. 53, Aug. 15, 1925, p. 665.

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Large uses of steel in small ways; metal beds. *Iron Trade*, v. 77, Aug. 6, 1925, p. 314.

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Machines supplant hand molding methods. Pat Dwyer. *Foundry*, v. 53, Aug. 15, 1925, p. 647-650.

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## The Burden Bearers

Down the chute they come, helter-skelter, pattering away like huge hail stones striking a metal surface — fiery red, spherical masses of steel, disappearing in a mist of vapor into the quenching tank. They are burden bearers all, and each is physically fit to assume its obligation. They are constantly tried by precision methods, but never as yet found wanting.

This is a story of steel ball manufacturing, a very interesting process, and an exacting one, as performed by the Standard Steel & Bearings, Inc., Plainville, Conn.

The steel, as raw stock, is carefully analyzed at the mill before being shipped to the manufacturer. Again, at the Plainville plant, it is subjected to rigid laboratory tests. Upon its acceptance, the bar stock is first shaped at the drop shop between the dies of a Bradley hammer. The heat required for this operation is 1800 deg. F., and the stock is slowly rotated during the forging operation to insure proper grain structure. A transformation has taken place between hammer dies, and the bar emerges resembling a string of steel balls. Through use of a punch press the string is cut apart and the ball forgings are ready for the heat treatment that follows.

The balls are first normalized at a temperature of 1500 deg. F. to relieve all possible strain in the steel structure. They are then annealed and this process is accomplished by heating the steel to 1440 deg. F. and holding this temperature for one hour. Cooling is effected in pans of powdered Sil-o-cel.

The balls are now ready for the grinding machines, where they are rough ground to within .010 in. of size and fairly round. Hardening is the next heat treatment, and a 45 min. period at a temperature of 1440 deg. F. is required for this operation.

The balls are quenched in water in a tank 15 ft. deep, and through the ingenious use of chutes, each ball travels approximately 25 ft. before reaching the collecting basket.

An inspection for hardness is made at this time, followed by another heat treatment—tempering. Oil tempering baths are used for this process, held to a temperature of 315 deg. F. for 25 min. This completes the heat treatment, and the balls are now passed along to the grinding department for final operations. These consist of lapping operations employing special lapping machines where an abrasive of oil and emery is used to obtain the required degree of fineness. Polishing is then accomplished through the use of tumbling barrels, producing the exceedingly high degree of burnish required.

The balls are now sent to the inspection department where they are examined for defects, fire-cracks and workmanship. They are also gaged for size. This size is held to one-ten-thousandths of a ninth for accuracy. It is interesting to note that with a 9/16 in. diameter, ball, 13 deg. change in room temperature will cause a change in measurement of 1/2 of one-ten-thousandths of an inch.

This concludes the story of steel ball manufacture, but let it be added and ever remembered that gas, 2,000,000 cubic feet of it per month, is the exclusive fuel used in this exacting series of heat treatments necessary to produce the sterling quality of "S. R. B." steel balls.—Gas Age Record.

## The Story of Cold Drawn Steel

As in the case of the blast furnace, the furnace is only one of the necessary units. A scrap yard is necessary, in which the incoming materials are received and later transferred to the charging boxes. Usually provisions are made to handle scrap, limestone, ore, ferromanganese, etc., under one crane runway. The scrap is handled by an electro-magnet, the other materials by a grab-bucket or bins. Modern open hearths operating in conjunction with a blast furnace use a metal mixer. This is a large receptacle built of plate and lined with fire or silica brick. It operates on rollers so it can be rotated in either direction. The iron is poured in at one side when coming from the blast furnace and drawn off at the other side, where it can be weighed, when required for the open hearth furnace.

Materials are handled in charging boxes made of cast steel or plate having a cubical capacity of 16 feet. They are carried transversely on cars, usually four to a car, to the front of the open hearth furnace. Here they are handled by the charging machine which is electrically operated. This is the most essential part of the labor saving equipment about an open hearth plant. It consists of a wide truck which runs on two tracks about 20 feet apart paralleling the furnaces. On the truck is a carriage which operates at right angles to the truck. This truck carries a large hollow arm known as the "charging arm" or "peel." Inside this arm is a bar called the "locking bar." After the charging arm drops into the socket at the end of the charging box, the locking bar engages and holds it in place. The machine then picks up the box, carries it forward into the furnace, rotates it to remove the charge and then withdraws and places the empty box on the car.

The overall dimensions of a 100 ton furnace are about 80 x 20 ft. The hearth itself will be about 40 ft. x 15 ft. The bath will be 20 to 24 inches in depth.

The bottom and banks must be of basic materials neutral to any chemical action from the basic slag. The bottom and sides are usually built of 9 inches of magnesite brick covered by about a foot of a mixture of burned magnesite and open hearth slag in the ratio of 75 per cent to 25 per cent, which serves as a protective covering. For patching after a heat has been tapped, dolomite, a highly basic refractory material, is used.

There is as much brick work below the charging floor as there is above. The slag pockets and regenerative chambers are located below the floor. The slag pockets catch material carried over by the outgoing gases. The function of the regenerative chambers is to heat the incoming air and gases. These chambers are large rooms arranged in pairs at either end of the furnace. They are built up of checker baffles of brick work. If producer gas is used the total space occupied per ton of furnace capacity is 120 to 150 cubic feet. For a 100 ton furnace the volume of the checkers for the air chamber would be 3500-3600 cubic feet and for the gas chambers 2500-2600 cubic feet. The dimensions would be about 31 ft. x 11½ ft. x 16½ ft. respectively.

A total of the equivalent of about 1,000,000 nine inch brick are required to build a 100 ton furnace complete.

The time required to make a heat will vary from 8 to 12 hours depending upon the design of the furnace, the fuel, whether hot or cold iron is available, and the grade of the steel.

A roof will last from 250 to 350 heats. The walls from 100 to 125 heats. About every 3 months the furnace will have to be rebuilt from the floor up. This will entail a cost of about \$30,000. About twice a year the furnace will have to be rebuilt from the checkers up. All of the checker brick will not have to be replaced, but this rebuilding cost will run about \$40,000.00.

The fuels used are natural gas, fuel oil, tar, coke oven gas, producer gas, or powdered coal. Natural gas is the best from the point of heat value, freedom from sulphur, and ease of control. With good scrap and iron available and natural gas as fuel, it is possible to produce steel in the open hearth furnace as low in phosphorus and sulphur as the best crucible tool steels. From 5,000,000 to 6,000,000 Btu. per ton of steel produced are consumed when using natural gas and from 6,000,000 to 8,500,000 Btu. per ton with other fuels. The consumption of the various fuels per gross ton of steel produced will average as follows: natural gas 5000 cu. ft., coke oven gas 8,000 cu. ft., with 16 gallons of tar; tar alone, 45 gallons; producer gas equivalent of 600 pounds of coal, and powdered coal, 500 pounds.

A typical charge for a 3½ per cent nickel steel heat (2,320 analysis) would be:

|                                                           |         |
|-----------------------------------------------------------|---------|
| Scrap .....                                               | 120,000 |
| Hot metal (iron).....                                     | 100,000 |
| Manganese spiegel (20 per cent Mn.)....                   | 10,000  |
| Iron Ore (50 per cent Fe).....                            | 6,000   |
| Limestone (about 10 per cent of the scrap and iron) ..... | 22,000  |
| Burned lime (about 10 per cent of the stone) .....        | 2,000   |
| Pig nickel .....                                          | 8,085   |

The stone and lime are charged first, the ore on top of the stone and the scrap last. The molten iron would not be charged until several hours after the other materials. It is usually added, however, before all of the scrap melts. The chemical action will be started by the ore and increased by the lime. By the time the charge is melted, most of the phosphorous, silicon, and manganese will have been oxidized and have become part of the slag.

Then follows the refining stage during which the impurities are further removed, the proper slag obtained, and deoxidation effected. The alloying additions are made and the heat tapped and poured from the ladle into the molds. After the steel has solidified in the molds, the latter are stripped mechanically from the ingots and the hot steel delivered to the blooming mill where it is properly reheated in soaking pits and put through the first rolling operation into semi-finished steel, billets.

Various factors will determine the size of the ingot cast; the furnace capacity, the size of the blooming mill and bar mills, the finished product, and general scheme of roll design. The usual practice is to roll the ingot to a bloom, a rectangular section, usually square, and 36 inches or over in area. This bloom is then rolled into a billet of the proper size for the mill which converts the finished product.

### Rolling Mills.

Mills are rated in size according to the distance from center to center of the pinions; that is, 40 in..

(Continued on page 417.)



# Steel Treaters Annual Convention

Exceptional Facilities Afforded by Cleveland's New Public Auditorium Insured Success

THE seventh annual convention and exposition of the American Society for Steel Treating which was held at Cleveland the week of September 14th has passed into history as the crowning effort of the many achievements already credited to this growing organization. Among the predominating factors in the success of this year's gathering were the unusual facilities of the Cleveland Public Auditorium for handling the exposition and its convenient location to the hotels. The capacity crowd was well taken care of by Cleveland's many fine hotels, and with a registration of approximately 5,000 and an attendance of over 40,000 little if any confusion or disappointment was experienced in securing hotel accommodations.

Exceptionally large attendances marked the technical sessions this year. At other conventions of the society the absence of preprints of the papers to be presented tended to hold down the discussion. The preprinting of papers this year was a departure over previous meetings and greatly stimulated interest in

the discussions. The technical sessions were more efficiently handled than ever before because this year is the first time that the steel treaters have made any determined effort to handle papers on a definite schedule with timed discussion.

On Wednesday morning the annual business meeting of the society was held at Hotel Cleveland. Mr. W. H. Eisenman, secretary, reported that the membership was 3,360 on August 31 as against 3,062 a year ago. The gain of 298 or 11 per cent is in keeping with the progress reported by the society for the last few years.

Mr. Eisenman briefly commented on the work of the recommended practice committee, stating that to date 243 pages of data sheets covering 38 subjects had been issued. He also announced that the 1926 convention and exposition will be held in Chicago the week of September 20th. The exposition will be held at the Municipal Pier and it is expected that all who desire space will be accommodated. This year 90 requests for space were turned down for lack of facilities.

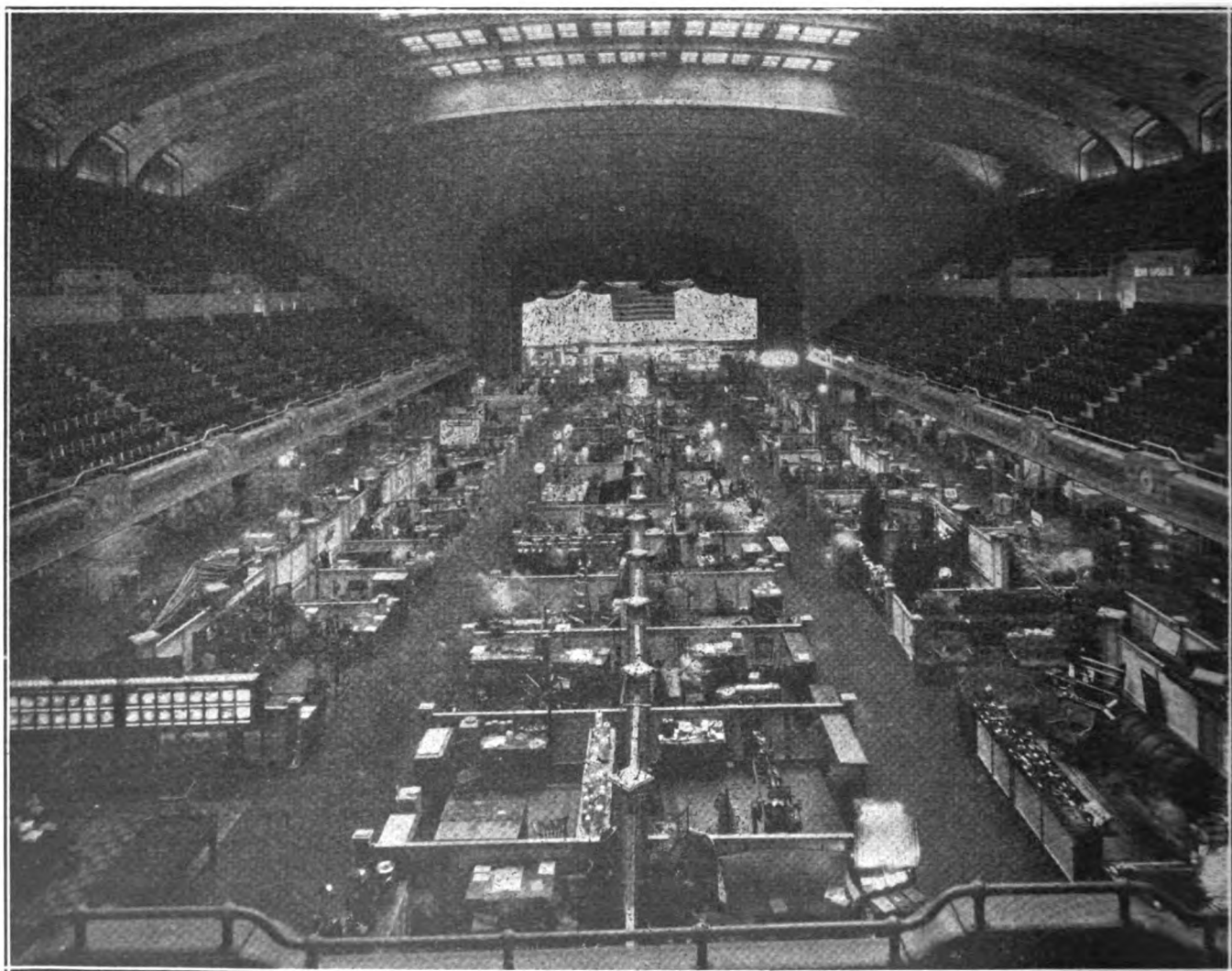


FIG. 1 — Birdseye view of the interior of the Auditorium, showing general arrangement of booths.



The annual banquet was held at the Hotel Cleveland on Thursday. The toastmaster was George M. Graham, vice president Chandler Motor Car Company, Cleveland. W. R. Hopkins, city manager of Cleveland, made the principal address of the evening, speaking on "City Governments." This was followed

by conferring on Dr. Charles F. Brush an honorary membership in the society. W. S. Bidle, president of the society, announced that Arthur G. Henry of Chicago had been honored with a founder membership by the board of directors, the presentation to be made at the convention next year in Chicago.



FIG. 2 — A glance at several of the many finely conceived exhibits which featured the Steel Treators' Convention.



# The Iron and Steel Exposition

TO the Philadelphia Section belongs the credit of having carried through to its successful conclusion this annual exposition sponsored by the electrical men of the steel industry. Separate views of a number of the exhibitors' booths give an adequate idea of the scope of the undertaking.

Of equal interest, however, to the members of this technical organization were the papers given by those many authorities upon their special subjects, and the interesting discussions which followed the speakers.

A brief outline only of the most note-worthy papers is here possible.

## D.C. Armature Windings for Multi-Polar Generators and Motors—Frogleg Windings

By W. H. Powell\* and G. M. Albrecht\*

This paper is intended to review the development of the art in the winding of drum type direct current armatures, and then to describe some recent improvements which have been made in the balancing of the circuits whereby commutation has been improved, capacity increased for a given speed or speed increased for a given capacity, speed regulation of motors, or voltage regulation of generators, adjusted by a slight shifting of brushes without impairing commutation. There will also be described some tests made under abnormal conditions to show the effect of the balanced windings when the magnetic circuits have been unbalanced.

The paper is divided into three parts, the first being elementary with a brief review of the development of the art and a description of the new winding, the second is a discussion of the results obtained, and the third is a technical description of how the connections are made in order to obtain balanced circuits on multiplex windings.

### Part I.

In the modern drum type d.c. armature with coils embedded in slots in the core, there are two types of windings now in use, viz., the series or two circuit winding, also known as the "wave winding" and the parallel or multiple circuit winding known as the "lap winding."

The series winding consists of a coil of one or more turns whose active conductors are placed in slots which are approximately one pole pitch apart and whose ends are soldered to commutator bars which are approximately two pole pitches apart.

The maximum capacities of large machines for a given speed or the maximum speed for a given capacity can be materially increased by the use of multiplex "Frog Leg" windings since:

1. The voltage between adjacent bars can be made equal to approximately one-half of the complete armature coil, and if conditions demand it, the voltage may be made one-third, one-quarter, or a smaller fraction of that of one complete coil and there are no external connections from back end of armature under the core to the commutator.

2. The number of circuits between adjacent brush studs can be made two, three or four or more and each coil in these windings is so interconnected with every equipotential coil that there is a perfect division of the current between the various windings so that no burning of alternate bars occurs, and there are no external cross connectors of any kind whatsoever on the armature.

The continuation of this paper was a series of comparison tests showing the relative values of different windings, with a series of curves plotted to indicate that stable operation is obtained, and that sudden overload shows no tendency for motor run-away.

## Electric Heat Treating Furnace Applications

By E. A. Hurmet†

Probably the first commercial development in the application of electricity to an industrial heating process was for heat treating heavy armor piercing projectiles, about 1911. This was a 125 kw. capacity vertical furnace, about 5 ft. high and 30 in. inside diameter. Due to the nature of the products heat treated, this pioneer installation was known only to a few, so it is generally acknowledged that the first real development in the application of electricity to an industrial heating process, was on the enameling ovens used in the automobile industry, about 1914. It is interesting to note that these applications were several years later than the first installation of an electric arc melting furnace. The electric oven for enameling overcame many of the difficulties experienced with combustion ovens and the use of electricity for this process is now almost universal.

### Soaking Pits.

After the ingot comes from the open hearth, or electrical furnace, the first process requiring heat is the soaking pit, where the ingots are brought to the proper temperature and allowed to remain until the temperature becomes uniform.

### Reheating Furnaces.

The next heating process in progressive order is the reheating furnace for rail, structural, sheet — bar mills, etc. To date there have been no installations of electrically heated reheating furnaces and as the temperature required is about 2500 deg. F., a furnace similar to the electric soaking pit would be required.

### Finishing Processes.

Next in order follows a series of finishing processes requiring the application of heat at somewhat lower temperatures. One such is the "pickling" process in sheet and tin mills. "Pickling" is done in a vat usually heated by steam at a temperature of about 500 deg. F. In electrically driven sheet and tin mills it is necessary sometimes to maintain a steam boiler with its cost of attendance and operation, solely to supply heat for this process.

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†Manager, Steel Mill Section, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

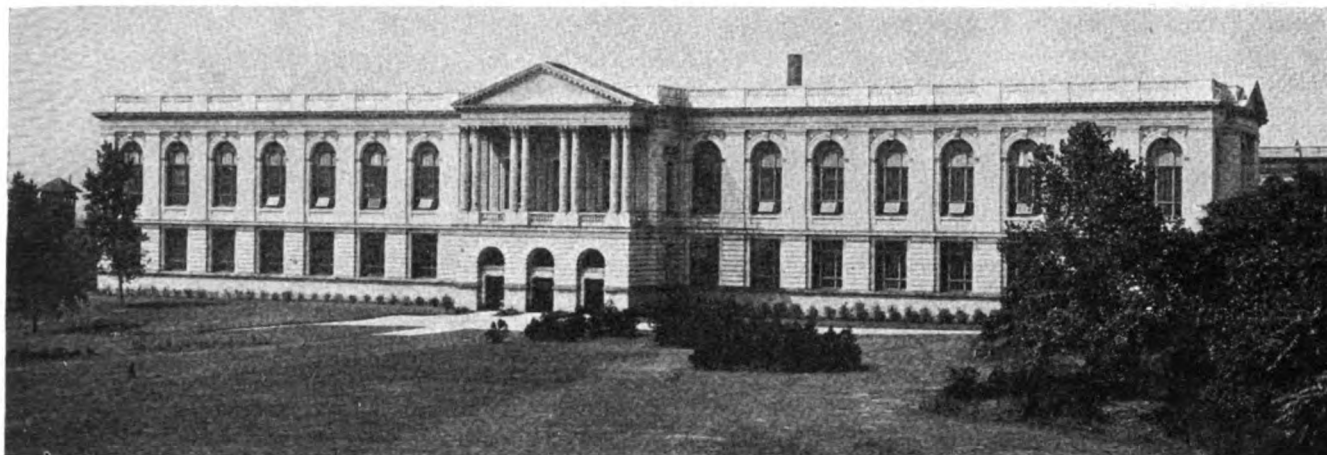


FIG. 1 — Exterior view of Philadelphia Commercial Museum where A. I. & S. E. E. Exposition was held.

### Bright Annealing.

For bright annealing strip steel an electric furnace equipment was recently installed at the Stanley Works, New Britain, Connecticut, as a test unit to determine the advisability of commercial bright annealing unstripped steel. This furnace is now running on intermittent commercial production and the present operation shows attractive economies in power consumption.

## Electric Melting Furnaces

By J. A. Seede\*

Although arc and induction types of electric furnaces for melting metal started on an even basis in occupying the attention of inventors and builders over 25 years ago the superiority of the arc furnace for the average user was soon indicated by its ability to make heats of different metals on an intermittent cycle and gave it a pre-eminence which caused its widespread use. This, as we all know, has resulted in its occupying a well established position in the iron and steel industries. In 1904, two 4 ton, two electrode, single phase Heroult furnaces were sold in this country, one to the Firth-Sterling Steel Company and the other to the Halcomb Steel Company. At first regarded more as laboratory instruments than commercial devices, their inherent qualities soon demonstrated their fitness for an important place in the manufacture of fine steels, and five years later, a 15-ton furnace of the same type, except for three phase operation, was put in operation at the Illinois Steel Company, South Chicago, Illinois.

Two-voltage operation for steel melting furnaces is now practically universal, continued investigation indicating that there need be no deleterious effect on the product and a decided saving in power and electrode consumption, and increase in production. The differences between various furnace equipments are confined to range in voltage between electrodes, power available at various voltages, means for varying the voltage, amount of reactance, its location and control and similar matters, together with mechanical and operating details.

\*Industrial Engineering Dept., General Electric Co., Schenectady, N. Y.

### Furnace Construction and Practice.

It is, perhaps, needless to state, that up to date furnaces are much superior to those of 25 years ago, not only from the standpoint of construction, but especially from the standpoint of operation — such as charging, adjusting of electrodes, room available around the furnace and many similar details. These points were taken up in the 1924 report of this committee, and the reader is referred to that report.

The largest electric furnaces for melting steel, or refining molten steel, in this country at the present time are as follows:

Two 3-electrode Heroult furnaces at Naval Ordnance Plant, Charleston, West Virginia, each of 40 tons rated holding capacity, the transformer furnishing 3300 kva. a 110 volts, 3 phase, 60 cycle to the furnace. This furnace is used in final refining of molten steel from an open hearth furnace.

One 8-electrode Greaves-Etchells furnace at Ford Motor Company, Detroit, Mich., 50 tons rated holding capacity, two transformers supplying 6000 kva. 3 phase, 60 cycles at 130 volts between movable electrodes. On account of the high capacity of the transformers, this furnace is designed for use both in melting and refining steel.

One single ring General Electric 6 ton induction furnace at the Allegheny Steel Company, Brackenridge, Pa., taking 800 kw. at 8.5 cycles single phase from frequency changer set. This furnace is used chiefly for refining molten steel taken from melting furnaces.

### Induction Furnaces.

After many trials and failures the induction furnace, which is essentially a device for producing the highest quality product, has returned to its original design — that is, a single ring, single phase type.

Perhaps the biggest advance in electric furnace matters has been the recent demonstration of the commercial feasibility of melting metals in an ordinary clay graphite or similar crucible, surrounded by an edge-wound copper coil, supplied with power at approximately 500 cycles. This type of Ajax-Northrup high frequency furnace offers many possibilities, not only in the melting of non-ferrous metals and alloys, but also in the manufacture of relatively small quantities of high grade steel, say in 500-pound heats.



## Extending Heat Cycle in Boiler Rooms by Use of Preheated Air for Combustion Purposes

By Joseph G. Workert

One of the outstanding achievements in fuel burning equipment is the use of preheated air for combustion purposes. Here lies the ultimate opportunity for extending the heat cycle in boiler plants far beyond the limits of anything heretofore accomplished. Attempted theories concerning heat interchangers and vacuum economizers have at times in the past nourished the hope that a boiler cycle could be evolved which would have the opportunity of absorbing all the heat in the gases down to the theoretical temperature of the air in which the phenomena took place. Results already accomplished with air preheaters point the way in the near future to accomplish this result in a simple and practical way. Not only is there a direct benefit due to the heat recovery from the waste

### Types of Air Preheaters.

Quite a number of designs of air preheaters are now coming into general use. Most of them come within one of the following three types:

- (a) The Plate preheater.
- (b) The Tubular preheater.
- (c) The Rotary air and gas preheater.

### Care of Preheaters.

Certain elements in connection with the use of preheaters must be given careful consideration in their operation. In all types of preheaters, there is a deposit of soot or tarry matter on the metallic surfaces which retards heat transference.

### Types of Furnace Walls.

It has been found in combustion work that certain elements that have contributed largely to the thermal

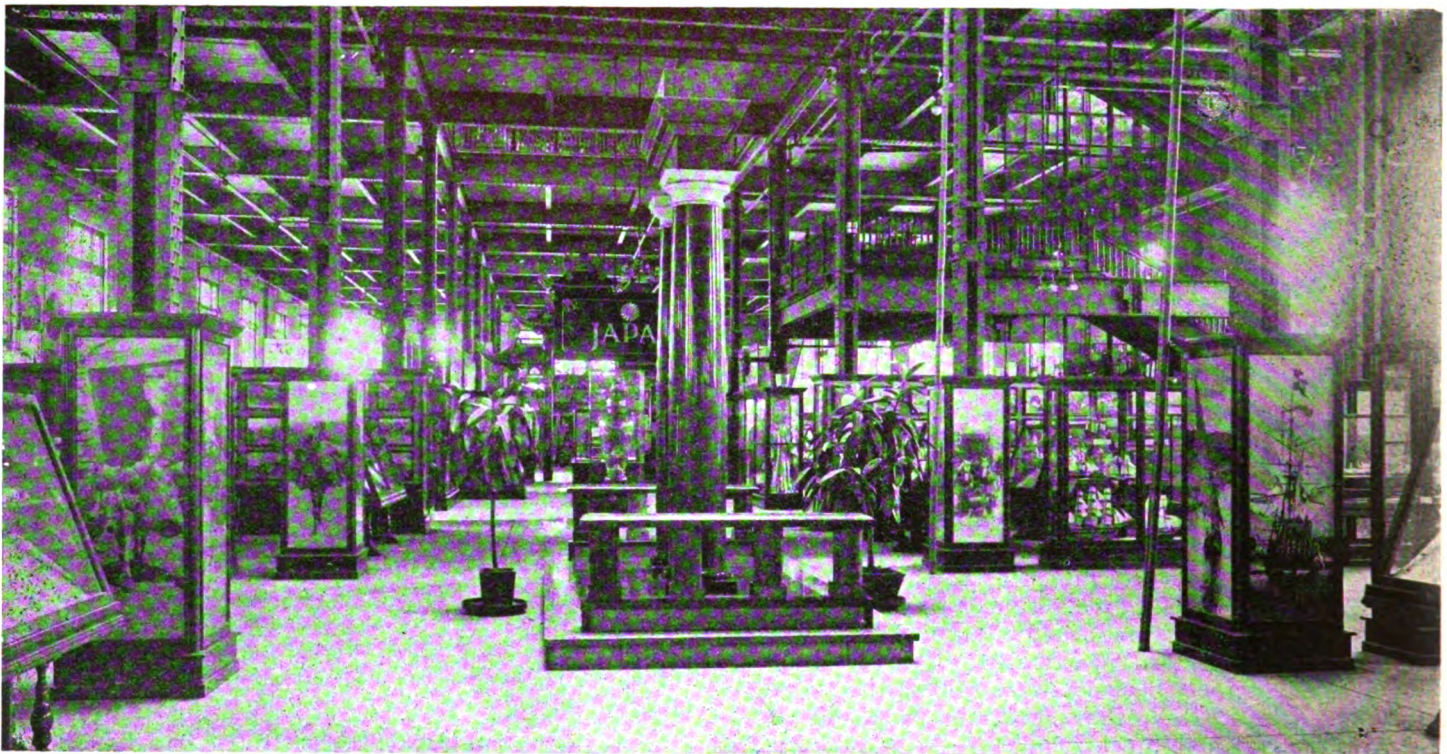


FIG. 2 — Interior of Commercial Museum, showing permanent exhibit.

gases but an indirect benefit of very substantial proportions is secured by this simple process. Combustion processes and fuel bed conditions are markedly improving. Less air is required to support the processes of combustion, and more uniform fuel bed conditions are attained. It is easier to burn coals which are sensitive to smoke, entirely without smoke.

### Cost of Preheated Air.

There is a certain amount of waste heat from flue gases that can be obtained at a low cost. If we attempted to preheat the air for combustion purposes to say 100 deg. F. this preheat could be obtained without much additional expense for handling the hotter gases, and the cost for preheated air equipment would be small.

†Vice President, American Engineering Co., Philadelphia, Pa.

efficiency of fuel burning have brought into use structural features of furnace design that are rapidly coming into general use. This has led to a furnace wall design that has embodied in it certain features for reduction of radiation losses. There are at the present time a variety of opinions as to the relative merits of these wall designs.

There are several forms of furnace walls that are now being used in connection with steam boiler furnaces. These walls can be grouped in four classes, as follows:

- (a) Water-tube screen.
- (b) Finned tube water wall.
- (c) Refractory and air duct wall.
- (d) Combination of water tube and refractory.

All of these types are in actual service in one plant or another, but for a particular set of conditions careful consideration should be given as to the



one that would best serve the local coal and operating conditions.

It might be well to summarize briefly the advantages afforded by the application of preheated air to stoker operation.

1. The efficiency of the modern stoker and boiler and superheater at 200 per cent boiler rating will be 83 per cent.
2. The efficiency of the modern stoker, boiler, superheater and preheater at 200 per cent boiler rating will be 90 per cent.
3. The modern stoker can be operated at 500 per cent boiler rating continuously.
4. The modern stoker can be operated to handle peaks of short duration up to 700 per cent boiler rating.
5. The  $\text{CO}_2$  performance with preheated air will range from  $15\frac{1}{2}$  per cent to 250 per cent boiler rating to  $16\frac{1}{2}$  per cent at 350 per cent rating and above.
6. Combustible loss in refuse will be less than .7 of 1 per cent of Btu. in coal or 7 per cent combustible in refuse.
7. 80,000 Btu. for maximum rating can be liberated per cubic foot of furnace volume per hour.
8. It is easier to burn coal which is sensitive to smoke, entirely without smoke.
9. Elimination by introduction of heated air in refuse of continual cooling and heating of fine particles of ash, resulting in easier handling of refuse of fuel bed.
10. Preheated air changes the character, proportions and efficiencies of the fuel burning portions of the modern stoker.

### Selection and Maintenance of Oil Circuit Breakers

By George A. Burnham\*

The subject of switching equipment for use in steel mill service is one, which up until recently has not received the consideration of the steel mill electrical engineers that it should. It is only within recent times, due to the rapid development of the Steel Mill Industry that this subject has come to the fore and has demanded attention.

It is the intention of this paper to take an imaginary steel plant and show the growth from its early stage up until the present time; to indicate during the various changes the effect on the equipment installed. The paper will also attempt to show how it is possible to calculate what the requirements of the necessary switching equipment will be to handle the service that is demanded, and also the care necessary to keep this equipment in good operating condition. This imaginary plant under discussion represents average growth. In this plant are located blast furnaces, open hearths, blooming mill drives, structural mill drives and various other mills and auxiliaries which are part of a large steel plant.

When originally built this plant, of course, like the rest of the older steel plants, had all main rolls steam driven. The use of electric power was therefore confined to lighting and small auxiliary service. For this reason the generating equipment consisted

of a few gas engines. There were also installed a few motor generator sets for supplying d.c. power for various auxiliary drives and machine tools, power for mill lighting was obtained from transformer banks distributed through the plant. The installations of switching equipment corresponding to this period are very interesting in that they show the lack of attention given to what is now considered proper safeguarding of the equipment and the operators and the tendency to put equipment in a corner or in some crowded place which was entirely inadequate for the installation.

This steel plant expanded in a normal manner and in line with this expansion it was decided to electrify one or two of the more important main roll drives. This made it necessary to put in a power house which contained two turbo generators.

### Blast Furnace and Coke Oven Operators To-Meet October 8

THE Eastern States Blast Furnace and Coke Oven Association will hold its Fall Meeting at Buffalo, New York, October 8, with headquarters at the LaFayette Hotel.

The social arrangements, which are always a feature of the operators' meetings, include a whole day of golf at the Park Golf Club or the Buffalo Country Club. In the evening, dinner will be served at the LaFayette Hotel at 6:30 promptly.

Following the dinner the technical session will be featured by Mr. Charles R. Meissner, Superintendent of the Coke Plant, Weirton Steel Company, who will present a paper under the title "Operating Practice and Experience with 14-inch Becker Type Ovens." Since these were the first 14-inch Becker type ovens built for the commercial manufacturer of blast furnace coke and since the paper is a compilation of data and experience in the operation of these ovens, the paper and discussion of this type oven should bring out many points of interest to both coke plant and blast furnace operators.

During the session arrangements will be made for visits by the operators or their guests to the various large steel and coke plants in the Buffalo district, among these being the Bethlehem Steel Company (Lackawanna Plant), Hanna Furnace Company, Donner Steel Company, Donner-Hanna Coke Corporation, Tonawanda Iron Corporation and the Semet-Solvay Company.

Dan M. Rugg is president and C. R. Meissner, secretary-treasurer of the association.

A group insurance policy involving a total coverage of \$263,000 has been placed on the lives of 119 employees of the West Virginia Malleable Iron Company, Point Pleasant, W. Va., by the Prudential Insurance Company, through its superintendent, E. G. Perkins, and agent, C. M. Ray.

The policy was arranged on the contributory basis, with the employees paying part of the premiums and the employing company assuming the remainder of the cost. The amounts of protection to which the workers are eligible varies from \$1,000 to \$5,000, according to the type of work to which they are assigned and those protected for the lesser amounts will be eligible to increases as they are promoted.

\*Condit Electrical Mfg. Co., Boston, Mass.



# The POWER PLANT

## Electrolytic Scale Prevention

Boiler Operation Can Be Simplified and Costs Reduced by  
Eliminating Corrosion and Scale

IT has been known for many years that corrosion and scale formation in boilers and condensers can be more effectively prevented by the electrolytic method than by any other.

Practical results, however, can be obtained from the electrolytic method only by combining electrical efficiency with mechanical simplicity and reliability.

To accomplish these results very definite laws must be known and observed.

1. The general use of a standard combination type of insulated current conveying an anode supporting member, which performs all the electrical and mechanical functions required to produce the desired results.

2. Aside from the anode metal the use of materials throughout that are indestructible by the action of heat, steam or water, at all temperatures to which they are exposed.

3. The practical simplicity, effectiveness and permanency of design.

4. The elimination of all electric short-circuit difficulties under the various conditions of operation.

5. The application of the process to both active and inactive boilers, condensers and metal structures in general.

### Cause of Corrosion.

The various causes of corrosion met with in modern engineering structures are now well understood. There is no doubt that the main cause of corrosion is a combination of electro-chemical reactions.

Boiler surfaces are attacked electro-chemically in the presence of injurious constituents in the water of the feed system, such as acids, grease, oxygen, etc. Galvanic action is set up by irregularities of composition of material due to lack of potential at various portions of the boiler, causes those portions which are more anodic than the adjacent, to become the wasting or corroding poles of numerous little couples or batteries and are eaten away, or corroded.

In overcoming the corrosive actions produced by the electro-chemical or galvanic action it has been the practice for many years to fit boilers and condensers with zinc and steel slab protectors without applying any external electro-motive force.

By this method, galvanic action of very moderate strength is produced, as zinc and steel are more anodic in comparison with the metal of the boilers and condensers.

When new, such slab protectors are effective due to electrolytic action which, though slight, counteracts the destructive reactions taking place at hundreds of points on the unprotected boiler surface. A certain percentage of free oxygen present in the boiler water

is absorbed or abstracted in production of zinc or iron oxide. The benefits derived are, however, strictly limited as to their capacity and are of but short duration. Experiments have shown, that as the zinc and steel slab is corroded away, the desired electrolytic action slowly, but surely, weakens. Zinc oxide or iron oxide, in the form of scale, is produced on the outer surface of the slab which becomes badly polarized and the electrolytic current rapidly dwindles to nothing.



Introducing the electrode through the manhole in a condenser.

Furthermore, the iron oxide or zinc oxide once formed gives rise to local action and the slab wastes away rapidly without protecting the boiler. This local action is most serious, as any remaining beneficial metal in the slab protectors is practically eliminated. As each slab protector is fully occupied with its own local action the slabs rapidly waste their remaining energies by accelerating the production, of zinc or iron oxide, instead of affording protection, against cor-



rosion to boiler surfaces in their vicinity, as originally intended.

Therefore, this slab protector system can only be considered as a "makeshift" against minor corrosion troubles. Furthermore, the most perfect system of slab protection yet devised, has failed to arrest the adhesion of scale on the internal surfaces of boilers, tubes, plates, etc.

When a sufficiently strong electric current is constantly supplied from an outside source to the anodes, the corrosive effect produced by the myriads of little galvanic couples in the surface of the boilers and condensers is entirely eliminated.

By regulating the strength of current thus supplied, the usual impurities contained in the boiler feed will be broken up electro-chemically and rendered innocuous, so far as their corrosive effects on the boiler or on the tubes are concerned.

Sufficient hydrogen is released, by electrolysis of the boiler water, to form a continuous film over the entire immersed boiler and condenser surfaces, thereby preventing the adhesion of grease, dirt, scale, etc., to these surfaces.

By increasing the strength of the electric current, any scale, etc., already adhering to the scaled surfaces, of boilers, will be broken up and deposited in the form of a harmless non-adhesive, non-corrosive sludge or powder.

Briefly described this system of protection for boilers and condensers is as follows:

A plurality of anodes fitted in each steam drum of a boiler or other equipment.

A plurality of anodes fitted in the circulating water spaces at the back and front ends of a condenser.

Specially designed current fittings attached to, but insulated from, the boiler or condenser or other part to be protected and adapted to support the anodes in the desired active position.

A positive low tension direct current of small amperage, supplied from a battery or generator and directly connected to the metallic anodes within the boiler or condenser.

The anodes, and the electrical connections thereto, at all times and under all conditions, insulated from the boiler, condenser shell or other metal part to be protected, which is always cathode.

An externally generated direct electric current, supplied to the anodes, and by them transmitted through the water (the electrolyte) to the boiler or condenser surfaces, which serve as cathode, completing the circuit by "grounding" the boiler or condenser shell and likewise the cathode pole of the current supply source.

The amount of current supplied to any particular boiler, condenser or other metal apparatus or structure to be protected, is varied and controlled by means of adjustable resistances which are mounted on the switchboard of the system.

An electrolytic action upon the water is adjusted and maintained so as to continuously destroy or divert the corrosive and scale forming impurities contained therein.

The anodes are adjustable with relation to the parts to be protected, such as the tube plates within the condenser.

The anode surface remains electrolytically active and is constant throughout the life of the anode.

By the continuous supply of a direct current of electricity to the boiler or condenser anodes, these anodes become the wasting poles and the boiler surfaces, condenser tubes, etc., the cathodes or non-wasting poles of the electrolytic circuit thus produced. Under these conditions continuous electro-chemical interchanges and combinations take place between the iron of the anodes, and the absorbed oxygen or acid radicals in the boiler water or in the condenser circulating water, which acid radicals would without the applied electric current produce hard scale.

The constant supply of current to the anodes stimulates these reactions and causes continual absorption by the anodes of the corrosive and scale forming constituents of the water, thereby, giving to the boiler surfaces, condenser tubes, etc., complete protection against corrosion.

The boilers and condensers, therefore, with their contents, may be compared to a huge electrolytic cell, in which the oxygen, acids and other corrosive impurities, held in suspension or in solution in the water are attracted to the anodes and chemically disintegrated, before being able to exercise their corrosive influences on the boiler or condenser parts, whereas, the hydrogen liberated and collected at the cathode, the immersed boiler and condenser surfaces, effectively protects these from harmful scale and corrosive scum adhesions.

It is of vital importance that there should be no reversal of current or polarity, that is, the anodes must always be connected as anodes and the boilers and condensers always as cathodes, otherwise the anodes will be protected and the boilers and condensers corroded. With this object in view, to prevent the reversal of flow of electric current from any cause while the system is in use a reverse current coil is inserted in the main circuit and should the flow of current be reversed accidentally, this coil automatically operates to break the supply circuit. In this way absolute assurance against reversal of current is attained.

### New Building for General Electric

Plans for the immediate erection of a large warehouse and office building at Santa Fe Avenue and Fifty-second Street, Los Angeles, Cal., by the General Electric Company, have just been announced. The plant, which is to be used as a distributing center, will cost about \$1,000,000, including land, buildings and equipment.

The plans being prepared by the Austin Company of California, call for a warehouse three stories high and designed to handle four additional floors. The warehouse besides housing handling machinery to move the stock will include a cafeteria for employees.

The office building will adjoin the warehouse, fronting on both Santa Fe Avenue and Fifty-second Street, and will be two stories high. One of the outstanding features of the office building is that it will be heated by electricity. Numerous departments of the General Electric Company at present are scattered over the city, but as soon as the leases on the places expire they will be moved to the new central location. The building is expected to be ready the first of the year.



### Soot Blower Protection

Experiments over a length of time and under various high temperature conditions resulted in a practical device. The assembled device takes the form of a barrier which deflects the gases away from the soot-blower element.

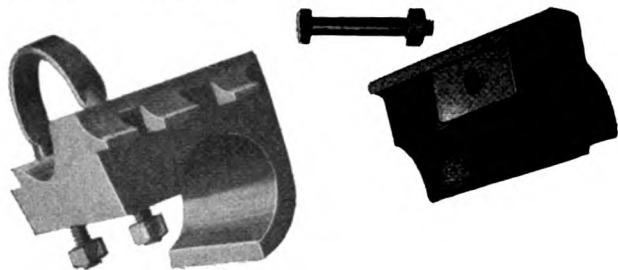
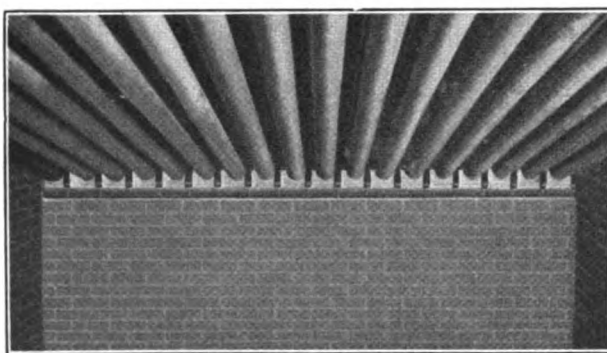
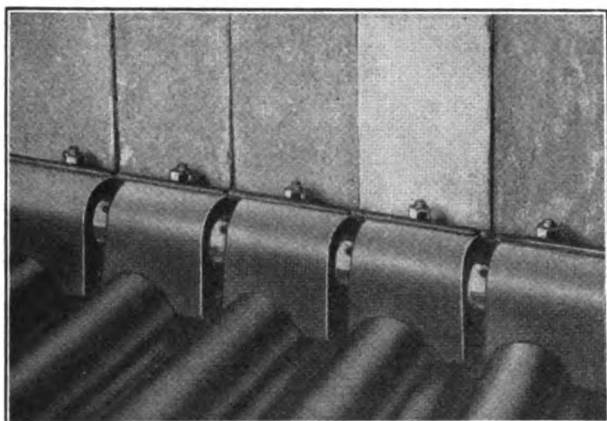


FIG. 1 — Shows simplicity of clamp.

With large horse power boilers of special design such as are being built today and in many other boilers continuously forced at high ratings, some soot blower locations necessarily require protection for the soot blower element.

These barriers are made in various designs and are constructed of special heat-resisting metals.

Diamond Barriers have been thoroughly tested under actual service conditions where soot blower elements were exposed to high furnace temperatures.



FIGS. 2 and 3—Two views showing furnace with barriers in place.

Under these actual service conditions it was found that the barriers accomplished the three following results:

No. 1. They place a barrier in the path of the gases, thus preventing the scrubbing action wherever

the inert gases which usually surround the soot blower element are constantly swept away to be replaced by an oxidizing atmosphere. This scrubbing action was long ago determined to be one of the factors which brought about the premature failure of the soot blower element.

No. 2. It was found that these barriers maintained a somewhat lower temperature of the soot blower element than would be possible if the soot blower pipe were exposed. This lower temperature was brought about by the fact that the barriers were fastened to the boiler tube and the heat surrounding the blower pipe on the outside of the barrier is absorbed and transferred through the casing to the water inside the boiler tube.

No. 3. The barriers afford the maximum protection possible for the soot blower from the radiant heat of the furnace.

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### Mesta Machine Company Directors

The directors of the company are: Harry F. Wahr, J. O. Horning, Mrs. Pearl R. Mesta, W. J. Hirth and G. E. Townsend.

## Discourse on Draught for Rolling Mill Furnaces

(Continued from page 404.)

tubes in the one end to allow for expansion. Five tubes on top of box and five on bottom. On each end of preheater there would be bolted a 6-in. airtight steel box into which air from tubes would flow. On the one end where air is blown in by fan the steel box would be divided into two compartments, one separating the five upper intake air tubes and the other the hot air which is returned through five lower tubes, which are connected with pipe leading to combustion chamber of furnace. There would be valves to control air supply.

Basing this preheater on 1400 deg. F., it would preheat 350 cubic feet of air per minute 900 deg. F. or more. Preheater would be built directly under the stack and both flues of furnace would enter bottom of preheater, passing through it up into stack. Proper care should be made in construction of preheater to allow for expansion. No care or cleaning will be required. You can divided this mechanism into two parts, half air preheating capacity for each flue and connecting both with pipe. The result will be the same.

Air preheating mechanism would utilize smoke, flame and wasted gases from each furnace and heat the draught for combustion purposes for each furnace from 600 deg. to 1200 deg. F., or as hot as process requires, would have these merits:

1—Of the numerous merits of this mechanism, the elimination of the various complications with which the heater or furnace man has to contend, would so simplify his work that the output would be about 25 per cent more. The rolling process would be simplified.

2—Uniformity of heat on metal.

3—Desirable soft heat.

4—Will eliminate oxidation and scaling.

5—Will, to greatest extent, do away with pitted or rough rolls, thereby resulting in smoother sheets.

6—Will not break one roll where four are now broken.

7—Will require less motor power to draw metal through the rolls on account of the soft desirable unscaled uniform heat.

8—Will economize from 2 to 3 per cent on sheet bars that is wasted in rolling process, namely scrap, for the reason you will have soft uniform heat.

9—Economy on fuel from 25 to 50 per cent.

10—Avoids the necessity of overheating furnace, which causes drip and dirty metal.

11—Simplifies rolling and heating process as it will do away almost entirely with stickers. A superior quality of product will also result.

### Logic Involved.

Hot draught will so greatly improve the combustion that excess air, the cause of much complication in rolling mill furnaces, will be an impossibility.

You will not use as much preheated air for combustion purposes as there is cold air at present for combustion purposes.

## The Story of Cold Drawn Steel

(Continued from page 407.)

20 in., 10 in., etc., generally, this is the nominal diameter of the roll. The rolls for a blooming mill are made of steel or semi-steel. Those for a 40-inch blooming mill will weigh 26,000 pounds and are about 12 feet over all with a body of six feet.

Blooming mills are driven by steam engines or d.c. reversing motors equipped with rotary generator sets. A typical steam prime mover is a twin tandem condensing engine 44 in. x 70 in. x 60 in. of 20,000 hp. which will deliver 465,000 inch pounds torque at 140 rpm. A direct current reversing motor is in operation at the United Alloy Steel Corporation which will deliver 12,000 hp. at 50 rpm. furnishing 1,200,000 inch pounds torque at that speed. This mill can be accelerated from zero to 120 rpm., the maximum speed, in 2½ seconds. The friction load of a 2-high steam driven reversing blooming mill will consume about 70 per cent of the power, only about 30 per cent doing useful work. The power is utilized in this manner:

|     |                                     |
|-----|-------------------------------------|
| 27% | Friction of engine parts.           |
| 9%  | Pinions and spindles.               |
| 13% | Roll journals.                      |
| 21% | Acceleration in reversing.          |
| 30% | Useful power in reducing the ingot. |

With a 3-high mill using a 25-ton fly wheel, the distribution is as follows:

|     |                            |
|-----|----------------------------|
| 85% | Generated drives the mill. |
| 15% | Idle friction.             |
| 70% | Available for useful work. |

At many mills the bloom is rolled into the billet on an adjacent mill without reheating. For this work, a continuous or 3-high billet mill is most used. It is necessary to furnish a billet of special quality for hot rolled or cold drawn alloy steel. For that reason the practice at the United Alloy Steel Corporation is to allow the blooms to become cold, after which they are pickled and chipped to remove all surface defects before the billets are rerolled.

Representative sizes of billets for bar mills are 4 in. x 4 in., 2½ in. x 2½ in., and 1-11/16 in. x 1-11/16 in.

Bar mills are of the hand mill or semi-continuous and continuous type. New installations are invariably of the latter type and are motor driven. Hot beds or cooling beds are of special mechanical construction as are shears and coiling equipment.

Heating furnaces for both blooming mill and bar mills are of unusual type. The former are built with regenerators. They are vertical with top doors. The ingots are charged and drawn by means of a specially designed pit crane. Bar mill furnaces are generally of the recuperator type and are continuous; that is, the steel is charged at the rear and pushed forward to the hearth on skids. It is discharged as required at the front or hot end. Producer or by-product gas is the usual fuel addition to these fuels, coal is used in bar mill heating furnaces.

Probably no steel making equipment has undergone the revolutionary changes in the past quarter century as that of the design of rolling mills and rolling mill adjuncts. The motor has supplanted the steam engine, while the hand mill has given way to the highly specialized continuous or semi-continuous mill. Complete modern rolling mills will cost from \$1,000,000 to \$2,500,000—U-Loy News.

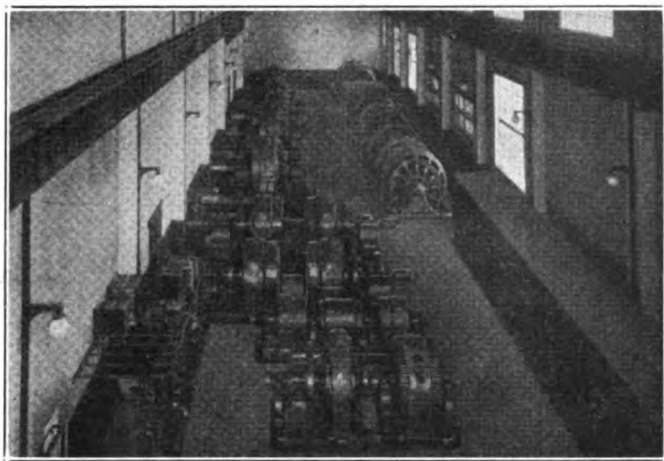


## TRADE NOTES AND PUBLICATIONS

**Main Roll Drives for Steel, Copper and Similar Mills** is the title of a recent publication by the General Electric Company.

The character of the booklet is evidenced by the photograph shown on the cover (see figure below).

A complete list of mill installations in this and foreign countries is contained with motor characteristics, and mill types.



Interior views at Jones & Laughlin, Bethlehem Steel, Youngstown Sheet & Tube, Wheeling Steel, Illinois Steel, Inland Steel, and many others are exceptionally convincing.

### The Commerce Yearbook for 1924

The third issue of the Commerce Yearbook, presenting a concise, readable, and graphic picture of the world's industry and commerce for 1924, with special reference to the United States, is ready for distribution. It is even better than its predecessors. The subject matter has been expanded; charts and maps have been freely employed to illustrate the text, and the reviews, statistics, and surveys are more comprehensive than ever. The publication date has been advanced by several months, thus lending an element of timeliness which will add materially to the usefulness of the publication.

The present issue comprises 718 pages, and represents the best economic information available for the year. All the statistics included were taken from reliable governmental and commercial sources and the surveys and analyses were made by highly competent business observers and specialists, located in all parts of the world.

Some of the interesting features are:

There is no other publication that covers such a wide range so completely and compactly.

Copies can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., or from any of the branch offices of the Bureau of Foreign and Domestic Commerce. The price is \$1.

### Otis Steel Adopts Regulation

The entire blast furnace plant of Otis Steel Company is to be equipped with Steinbart Burners. This includes both stoves and boilers. Additional installation to be made by the American Heat Economy Company include the following important steel plants: Tonawanda Iron Corporation, North Tonawanda, N. Y., four stoves; Inland Steel Company, Indiana Harbor, Ind., four stoves; Bethlehem Steel Company, Lackawanna, N. Y., (sixth repeat order), four stoves; Otis Steel Company, Cleveland, Ohio (third repeat order), four stoves, four 834 hp. boilers, two 500 hp. boilers, and one 100-ton open hearth furnace.

### Inspecting and Testing Automobile Axels

(Continued from page 391.)

erow Steel process of rolling. In Fig. 19 is shown the grain flow of a front axle steering knuckle.

Constant check is placed upon all major forgings to insure the proper grain flow and to prevent the occurrence and acceptance of cross grained material.

#### Cold Tests.

As a final check on axle parts, and as an assurance to the Engineering Department that the proper care has been used in the selection and treatment of the materials that enter into the axle, the important forgings are periodically subjected to cold bend tests. Heat treated forgings are selected at random and with the aid of tons of pressure, they are bent, twisted and flattened cold. Fig. 20 shows a group of these forgings that have been subjected to test.

#### Conclusion.

This completes the testing and inspection from a metallurgical standpoint. Much could be said upon magnetic analysis and the application of the X-Ray to detect the hidden dangers, but as these tests are still in their experimental stage it would not be fair to list them as the regular method of routine inspection. Every possible test is used which will help make the finished product one of absolute dependability. The axle manufacturer is ever conscious of the dangers that lurk should certain components of an axle fail, and he is therefore ever testing, ever inspecting and researching in order to make the axle the safest part of the motor car.

### Recuperation Offers Definite Savings

(Continued from page 403.)

9. The thin-walled construction results in a rapid transfer of heat from gas to air.

10. The counter-flow principle employed constitutes the most efficient method of heat transfer.

11. The use of standard unit tile renders the recuperator adaptable to any size of installation.

12. The entire construction consists of a simple assembly of tile on tile, without the use of props, slabs, or special shapes of any kind to connect the units.

## WITH THE EQUIPMENT MANUFACTURERS

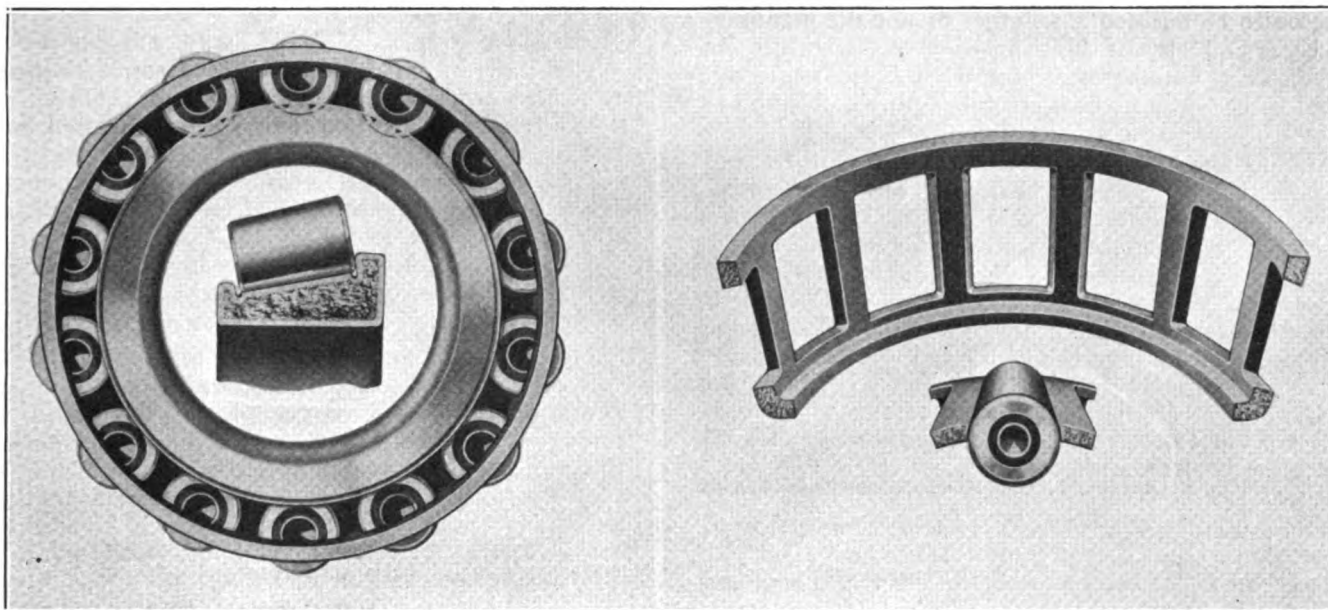
### Improved Timken Bearing

An improved type of Timken tapered roller bearing, differing from the well-known Timken bearing in major refinements, but retaining all essential elements, which have characterized Timken tapered design, is now in production.

Nickel-molybdenum steel of special Timken formula has been adopted for all bearings. The inclusion of the alloys, nickel and molybdenum, produce a steel possessing properties of grain texture, toughness, hardening, heat treating and machining which reflect favorably in the life of anti-friction bearings.

Varied refinements in the bearing itself are noteworthy. The design of the roll has been changed so that the surface of the large end presents a right angle relation to the center line of the roll. The contact then between the large end of the roll and the

the cone and roller assembly. Previously, the cage was cold pressed into the shape of a cup, the bottom stamped out and the pockets for the rolls punched out, one at a time, by an automatic punch press. The result of this single stamping operation was positive uniformity of cage pockets, yet a progressive error in alignment, due to stretching of the metal, as the indexing fixture advanced the metal cage to the final perforation. To correct this microscopic error, a multiple perforating die was developed which perforates all roll pockets in the cage, by a single impact. To further safeguard against any possibility of error during this operation, due to distortion, an inwardly turned flange has been retained on the smaller side of the cage. To insure smoothness and a perfect fit of the rollers in the cage the lateral edges of the cage are swedged inward so that the contour of the sides of the cage pocket conform to the contour of the roll.



rib of the cone is in two areas, the rib of the cone being slightly undercut. This two-area contact insures perfect axial alignment between the center line of the roll and the center line of the bearing at all times. Likewise there is always absolute line contact between the surface of the roll and the surface of the cone, and between the surface of the roll and the surface of the cup.

An added purpose served by the two area contact is self-alignment of rolls on cone in the cup without resorting to a cage fixture to retain the alignment. The primary purpose served by the cage is to retain the rolls, properly spaced about the cone, and to make the cone with its set of rollers a unit assembly. The skewing of the roll on the cone raceway is impossible, since the two areas on the end of the roll make generously separated points of contact with the shoulder or rib of the cone, as shown in the illustration.

The Timken cage has been improved along with

This operation is termed "swinging." Dies similar to the multiple perforator are used, so that all cage pockets are winged simultaneously. The inwardly turned flange and the result of the winging operation are shown in the illustration.

With the advent of more quietly running parts in certain machine installations the Timken Company has kept pace by reducing the noise in the bearing to a very marked degree, by the self-aligning principle and the accurately perforated cage. These special installations require a very definite uniform standard of quietness. To accomplish this uniformity, specially tested bearings are required. For this purpose an electrical sound testing machine was developed which measures the noise in a running bearing by means of an electric current. A sounding box connected to a telephone receiver, and a set of radio tubes, carry the amplified noise vibrations of a running bearings to a galvanometer connected to an arbitrarily indexed dial.



## BY-PRODUCT AND CHEMICAL NEWS

### Gas Men to Discuss Saving Coal and Oil

Problems affecting the future fuel supply of the country will be brought up for solution at the Seventh Annual Convention of the American Gas Association which is to be held during the first five days of the week beginning October 12 at Atlantic City.

The call to attend the convention, issued by H. C. Abell, president of the association, was sent to nearly a thousand gas companies and manufacturers of gas appliances and equipment, and arrangements are being completed to seat more than 5,000 delegates, committeemen and others interested in the conservation and application of heating fuels.

Recent developments in the oil and coal industries are responsible for much of the interest in the deliberations of the country's gas men this year. It is recognized that a situation has developed which will probably mark a turning point in the history of fuel. The question to be decided is whether or not the manufactured gas industry is in a position to substitute its product on a national scale for what is generally admitted to be the present wasteful methods of employing fast disappearing natural deposits.

Among those who will discuss this subject are Henry L. Doherty, of New York; R. M. Searle, president of the Rochester Gas & Electric Corporation of New York, Horace C. Porter of Philadelphia, Henry O. Loebell, vice-president of the Combustion Utilities Corporation, William P. Ryan and Robert T. Haslam of the Massachusetts Institute of Technology, Jerome J. Morgan of Columbia University, Floyd Parsons of New York, Arno C. Fieldner of the U. S. Bureau of Mines, and S. W. Parr of the University of Illinois. These are all among the foremost authorities on fuel application in the country.

While technical problems are naturally the most pressing, there will also be a general conference to deal with the question of public relations. The gas industry, in collaboration with the electric, telephone and street railway interests, is organized for this work on a national scale and has committees on public utility information in 36 states. This is said to be the first time that these committees have ever met together as a whole.

A gathering of industrial gas engineers of the country will be held to report on the results of the national advertising campaign which the gas association is conducting among industrial fuel users. It is recognized that with present high labor costs and constantly rising prices for nearly all materials, manufacturers of all classes are demanding more economical as well as more efficient methods of heating.

Gas engineers believe that manufactured gas is the logical means to this end, and point to the fact that the use of gas in industry has increased more than 1,000 per cent in the past 10 years as compared with an increase of 100 per cent in total gas produced. The next step, it is said, should be the development of the most efficient industrial appliances possible with special reference to particular uses like non-ferrous

metal melting, brick firing, vitreous enameling, glass hardening, varnish making, and food drying. The establishment of a national research organization for this purpose will be discussed.

An exhibit of gas appliances on the Steel Pier will be, as in former years, an outstanding feature of the convention. There will be 195 exhibitors as compared with 182 in 1924. This is nearly twice as many as there were four years ago and is considered an indication of the growth of the manufactured gas industry within recent years.

Luzerne County Gas & Electric Corporation has contracted with the U.G.I. Contracting Company, of Philadelphia, to furnish and install the Chrisman Cycle on water gas apparatus at the Nanticoke (Pa.) plant.

It is expected that the installation will be very shortly completed and it will result in much greater efficiencies and economies in plant operation.

The Lawrence (Mass.) Gas & Electric Company has placed order for the installation of U.G.I. Model "B" Automatic Control on their 9 ft. carburetted water gas apparatus.

This installation will include not only the control but the hydraulic operating devices and U.G.I. Master valve.

The installation is being made by the U.G.I. Contracting Company, of Philadelphia.

The Youngstown Sheet and Tube Company has contracted with the Chapman-Stein Furnace Company of Mt. Vernon, Ohio, to design and build two continuous ingot heating furnaces for their new seamless tube mill at East Youngstown. The furnaces will be of the recuperative type, with recuperators built of Chapman-Stein refractory tile. Each furnace will have a capacity of 15 tons per hour. Coke oven gas will probably be used for fuel.

### STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., OF

#### The Blast Furnace and Steel Plant

[Required by the Act of Congress of August 24, 1912]

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C. J. Keller, 5840 Solway St., Pittsburgh, Pa.

M. M. Zeder, 108 Smithfield St., Pittsburgh, Pa.

R. H. Thiess, 426 Byrne Bldg., Los Angeles, Calif.

Known bondholders, mortgagees, and other security holders holding 1 per cent or more of total amount of bonds, mortgages, or other securities: None.

L. L. CARSON, Business Manager.

Sworn to and subscribed before me this 23rd day of September, 1925.

CHAS. A. SEIBERT, Notary Public.

(My commission expires March 5, 1927.)



### Thomas H. Rogers Resigns

Announcement is made of the resignation of Thomas H. Rogers, General Superintendent of Follansbee Bros. Company plant at Follansbee, W. Va., resignation to take effect October 1.

Mr. Rogers is one of the oldest operating executives in this section. His first experience began at Leechburg, Pa., with Rogers & Burchfield. Later he went with the Bay State Iron Company at Boston. In 1885 he became associate with the Wallace-Banfield Company at Irondale, Ohio, and remained there until the plant was dismantled in 1900.

Immediately he became manager of the American Rolling Mill Company at Middletown, Ohio, and served in that capacity until 1904 when he came to Follansbee.

At that time the present plant of the Follansbee Brothers was in course of construction. Mr. Rogers supervised the construction of the plant and since then has been in the capacity of general superintendent, having been associated for that period with Wm. Banfield, who resigned one year ago.

Mr. Rogers is one of the pioneers in the steel industry and is considered a very capable operating executive. He completes 21 years of splendid service for the Follansbee Brothers Company this week and quits his post with an enviable record. He has a host of friends in the steel industry throughout the valley who wish him every success in the future.

J. S. McKesson, who has been Pittsburgh district sales manager of the McKinney Steel Company, Cleveland, and his assistant, George W. Crowl, will be transferred to the company's main office in Cleveland, as the company has decided to discontinue its Pittsburgh office.

Mr. H. D. Westfall has assumed his position as vice-president of the Weirton Steel Company. He was formerly manager of sales, Wheeling Steel Corporation, with which he had been associated for 22 years.

Philip S. Savage, formerly superintendent of coke-

ovens, By-Products Coke Corporation, Chicago, has returned to the Donner-Hanna Coke Corporation, Buffalo, as superintendent of operations.

Edward J. Dittmar, for 10 years superintendent of Paintermills of the Carnegie Steel Company, Pittsburgh, has resigned and associated himself with the Ames Shovel & Tool Company, Boston, as general manager of Ames plant, North Easton, Mass.

W. C. McKee, for several years general manager of the Pulaski Iron Company, Pulaski, Va., has entered the employ of the By-Product Coke Corporation, Chicago, which operates the Federal Furnace at South Chicago.

C. A. Timmons, for over 25 years with the American Sheet & Tin Plate Company at its mill at Elwood, Ind., and of late with the Bethlehem Steel Company, New York sales office, has joined the Fourway Realty Corporation, 341, N. E. Second Avenue, Miami, Fla. Other former steel men associated with the Miami company are: Theodore A. Gessler and W. P. Andrews, both formerly with the American Sheet & Tin Plate Company, George Damerel, Weirton Steel Company, H. H. Fuller, Bethlehem Steel Company, and John B. Kingsley, American Car & Foundry Company.

Arthur F. T. Wolff, of the Carnegie Steel Company, died Sunday, October 14.

After an earlier education in Germany, Arthur Wolff studied engineering at Stevens Institute, Hoboken, where so many Carnegie engineers have gained their education—he graduated and joined the Edgar Thompson engineering force in 1905.

For a number of years he served as steam and experimental engineer, devoted his energies to experimental rather than operating. During this period he supervised a very elaborate series of blast-furnace stove tests, availing himself of the unusual facilities offered by the 11 blast-furnace operation at Edgar Thompson.

About 1920 he was drawn into the city engineering offices, under Sidney Dillon, chief mechanical engineer.

His untimely death at the age of 45 will be mourned by a host of loyal friends.



## NEWS OF THE PLANTS

The Inland Steel Company, Chicago, Ill., has approved plans for further extensions and improvements at its mills at Indiana Harbor, Ind., with reported cost placed in excess of \$2,500,000. The work will include the installation of a new battery of 77 coke ovens of Koppers type, and auxiliary apparatus; the electrification of all present steam-operated units at Plant No. 1, including a 24-inch structural mill, 18-inch sheet mill, plate mill and merchant mill; and the construction of an addition to the power plant used for the No. 2 mills, with the installation of considerable additional power equipment. It is expected to give orders for electrical equipment at an early date, and place the project under way. A number of months ago, the company began work on a new blast furnace, making the fourth such stack at the plant, and it is expected that this unit will be ready to blow in by the close of the year.

The Penn-Seaboard Steel Corporation, Philadelphia, Pa., has plans under way for extensive improvements and additions in its Baldt works at New Castle, Del., where operations will be concentrated in the future. The expansion program calls for a new 60-ton furnace, and the construction of additional buildings to house a rolling mill. The last noted department will be removed from the present plant at Tacony, and new machinery provided for increased capacity at the new location. A number of other auxiliary departments will be transferred, also, from the Tacony works.

The Hudson Valley Coke & Products Corporation, Troy, N. Y., is pushing construction of its new local blast furnace and expects to have the stack ready for service by the close of October. Machinery, including skip hoist, etc., is being placed in position and finishing work, with stove erection and accessory features, well in hand. It is purposed to run the furnace for a continuous period and a working force is being recruited. The company is also completing the installation of a first unit of 55 coke ovens, and will begin production with this battery at an early date, running on a basis of close to 1,000 tons of coke per month. Orders have been received up to the present time, it is stated, for material for more than two months' continuous production. The complete plant will consist of three batteries of 55 coke ovens each.

The Latrobe Electric Steel Company, Latrobe, Pa., has plans nearing completion for the erection of two new additions in its plant, and will proceed with work at an early date. The structures will be each one-story, 60 x 400 ft., and 40 x 80 ft., respectively. New hot mills, electric annealing furnaces, heating furnaces and other auxiliary equipment will be installed. The expansion is estimated to cost close to \$175,000, with machinery.

The Illinois Steel Company, Chicago, Ill., is arranging to proceed with a portion of the expansion program at the South Chicago works, arranged a number of months ago, to absorb a total fund of more than

\$2,500,000. The present expansion will consist primarily of new rolling mills, designed for the production of alloy steel bars. The equipment will be electrically-operated in the different departments. The company is a subsidiary of the United States Steel Corporation. At the Joliet, Ill., works of the company, plans have been perfected for improvements in the boiler plant, with the installation of a new system of automatic regulation for steam pressure under various loads. The boiler station consists of six 1,000-hp. boilers, provided with double stokers of Coxe type. Work will be placed under way at an early date.

The Weirton Steel Company, Weirton, W. Va., has plans in progress for the construction of a new tube mill at its local plant, and expects to proceed with the project at an early date. A number of new sheet mills will be erected to provide for extensive increase in present capacity, as well as the manufacture of a number of additional sizes and grades of material. At the open hearth plant, the company proposes to build three new furnaces, each of 100 tons capacity, making a gross rating for this plant department of about 800,000 tons of ingots per year. Another feature of the adopted expansion program is the proposed construction of another blast furnace, with exact time of starting work on the stack still to be determined; it will be designed for a capacity of about 800 tons of pig iron per day, and will bring up the company output in this line to a gross of 550,000 tons of material per annum. This extension will be supplemented by enlargements in the coke oven plant, to include a new unit of at least 45 by-product ovens. Plans have been authorized for a new storage and distributing yard at the local works, with capacity of about 100,000 tons of pig iron and scrap. As recently announced, the company will soon begin work on new loading and unloading docks, including a new harbor for such purpose. Property was lately acquired for the last noted purpose.

The Empire Steel Company, Cleveland, Ohio, has been organized to take over and operate the local plant of the Empire Rolling Mill Company, recently acquired by A. W. Wheatley, head of the Delphos Manufacturing Company, Delphos, Ohio, manufacturer of iron and steel products, who will head the new concern. The plant consists of a group of six sheet mills and accessory departments, and will be developed to maximum capacity by the new owners at an early date. It is reported that tentative plans are under advisement for expansion, as well as improvements in the existing works. The property has been valued at \$1,000,000, but is said to have been secured for an amount below this sum.

The Vulcan Iron Works, Wilkes-Barre, Pa., has preliminary plans under way for the proposed rebuilding of the portion of its plant recently destroyed by fire with loss reported at close to \$100,000, including equipment. The reconstruction will cost approximately a like amount.

OCT 15 1925

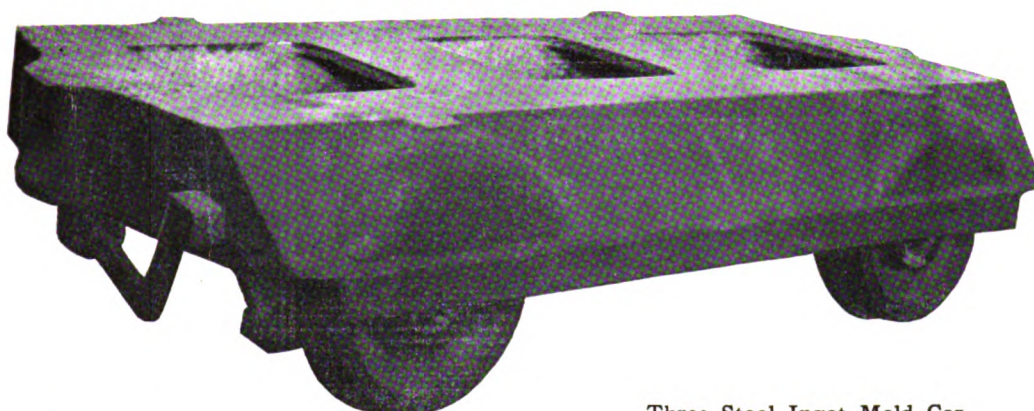
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